ARCHIVES of OPHTHALMOLOGY

VOLUME 13 (old series Volume 70) FEBRUARY 1935 NUMBER 2

A NEW THEORY OF BINOCULAR VISION

F. H. VERHOEFF, M.D.
BOSTON

The perception of depth in stereoscopic vision is obviously dependent on the spatial differences in the two retinal images of the view, for it is known that the act of convergence is not an essential factor in this perception. For the brain to detect these differences, the representations of the two retinas in the brain must be accurately correlated. A retinal area in one eye and another in the other eye between which, during stereoscopic vision, the brain cannot distinguish any spatial difference may be called corresponding retinal areas, and images on such areas must appear to coincide. Anatomic, clinical and experimental observations have conclusively shown that in the occipital lobes the two retinas are represented spatially. But just how precisely each retina is represented in the brain is not really known. The visual acuity of each eye is normally so great, however, especially as revealed by the alinement test, that the retinal areas represented as minimal units in the brain, at least in the foveal region, must be very small, and it is even reasonable to suppose that in the latter region all the cones have separate representations in the brain. This is indicated also by the fact that the binocular perception of depth is equally, if not even more, delicate than visual acuity.[1] In any case the retinal units must be so small that for convenience one may speak of them as points. The question as to whether or not the relationship of corresponding points is so close that these points are represented in identical places in the brain will be considered later.

If with one eye occluded, for example the left eye, one looks at a small isolated object in space, one places the right eye in such a position that the most distinct view of the object is obtained. One knows that its retinal image is then situated at or near the center of the fovea. If now the other eye is uncovered, one may see the object as two. If so, one then immediately sees the two objects go into each other and become one object. This act is called "binocular central fixation." The motor mechanism for this need not concern one now. The maximum visual angle subtended by the two images measures the heterophoria. If there

From the Howe Laboratory of Ophthalmology, Harvard University, and the Massachusetts Eye and Ear Infirmary.

1. Howard, H. J.: A Test for Judgment of Distance, Am. J. Ophth. **2**:656 (Sept.) 1919. Anderson, E. E., and Weymouth, F. W.: Visual Perception and the Retinal Mosaic, Am. J. Physiol. **64**:561, 1923.

is nearly perfect orthophoria for the distance selected, a weak prism may be used to elicit the phenomenon.

In binocular central fixation it is commonly assumed that in each eye the image of the object is brought on the center of the fovea, but this has not been positively demonstrated. However, by a simple test one can prove that each eye is so placed as to obtain the best view of the object. If either eye is covered while fixing an object binocularly, one finds that it is not necessary to change the position of the other eye to obtain the best view of the object. This test is only relatively exact, but for the present purpose it permits one to assume that in binocular central fixation each eye is placed in the same position which it takes in monocular fixation. One cannot, however, from the result of this test assume in addition that in such fixation the images are necessarily on corresponding points, since one of the images may simply have disappeared from consciousness. In my own case, however, I can easily demonstrate that the error of assuming that the points of binocular fixation correspond is less than one minute of arc. By long practice I have acquired such control of my convergence that I can produce and perceive the overlapping of the retinal images of a dot that is 0.16 mm. in size and situated at a distance of 30 cm. This accuracy is more than sufficient to warrant the assumption that in the experiments to follow the images of the objects fixed binocularly are on corresponding points.[2]

If an object, as is generally the case, has practically the same appearance when it is seen with one eye occluded as it has with the other occluded, it will also appear practically the same when seen with binocular central fixation. This phenomenon is so familiar that its remarkable nature is commonly overlooked. That one and one can make one instead of two should indeed be astonishing! It is generally called "fusion," but it certainly is not fusion, because the two images do not have the value of two when seen as one. I prefer, for the lack of a better term, to call it "unification," a term meaning simply that the two images are seen as one, and not implying any explanation of the process.

If one looks at a distant uniform white background with a black dot on it and holds a gray rod before the right eye, one may perceive two rods. If so, let one place the rod seen by the right eye in front

2. It may be of some importance to state that my visual acuity in each eye, with correction of moderate errors of refraction, is 20/10 by the Snellen test, and 20/12.5 by my circle test. My ocular motor balance and torsional deviation are within normal limits, my perception of colors is normal, and my binocular perception of depth is unexcelled. I no longer have any disturbing accommodation. For over thirty-five years I have been able to unify stereoscopic photographs or diagrams by convergence or divergence without the help of a stereoscope.

of the dot and keep it there. One now sees both this rod and the dot, the rod having a transparent appearance and the background a shadow on it. At times this shadow becomes completely gray except in the immediate vicinity of the dot; at times it completely disappears, and at other times it may show any gradation between gray and white in the whole or any part of it. It seems to one that these changes are dependent on the amount of attention one is giving to the rod or to the background. It is evident to one that when part of the rod partially or completely disappears it is to a corresponding extent replaced by the white background. Let this process be called, therefore, "replacement." Now imagine that in place of the dot there had been marked out on the background a faint gray homogeneous area of such dimensions that as seen by the right eye alone it would be exactly covered by the rod, and suppose that one could change the intensity of this area at will. Every one will probably agree that now the process of replacement would go on as before, and that it could be detected at times so long as there was any recognizable difference between the intensity of the rod and that of the background. When there was no such difference, and the process continued either completely or incompletely, what one would see would have a constant appearance identical with that of the rod when the latter was seen with both eyes. Since one knows that this is actually what one would see under this condition, and since it is inconceivable that some other process would suddenly occur just as the intensities of the images of the rod and that of the area became equal, one must assume that the process of replacement has continued. If, while still maintaining the same conditions, one removed the rod one would continue to see exactly the same thing, since the retinal images would remain unchanged. But now one would actually be fixing binocularly the area on the background.

It is now obvious that in the brain unification of images that fall on corresponding points is due to the process which has been called "replacement," and that when the images are similar one is entirely unconscious that the process is acting. If there is any one who thinks that the appearances would differ from those that I have described as occurring in the imaginary experiment, he can actually make the experiment by painting a faint gray area on the background and varying its intensity by means of a projection lantern.

Now let one inquire further regarding this remarkable phenomenon of replacement. In the foregoing observations only visible images have been dealt with, that is to say, retinal areas that can be distinguished from their contiguous areas by their intensity or color. But obviously one could better understand the phenomenon if one considered it in relation to the retinal unit areas. A retinal unit area may be defined as a retinal area within which consciousness cannot perceive spatial dif-

ferences. As already pointed out, the size of these areas is not certainly known, but for convenience one may assume that at least in the foveal region each cone is represented in the brain as a unit, although it will appear evident that such an assumption is not essential. For reasons to be given later, each retinal unit and its corresponding retinal unit must somewhere in the brain, presumably in the occipital lobes, be represented separately, but in the part of the brain concerned in conscious perception the two units must be represented by a single unit which may be designated the "conscious visual unit." For convenience one may conceive of this as occupying a circumscribed area in the brain, although this conception is also not essential. Possibly the conscious unit is represented in many different places in the brain, but always as a single unit. An image composed of conscious units may be termed the "conscious image."

There are good reasons for believing that the all-or-none law holds for the optic nerve, so let it be assumed that this law also holds for the brain. Then, since the response of a cerebral unit must be totally complete or totally incomplete, its effective intensity during a period of observation must depend on the frequency of the response, on irregularity in the response or on both of these factors. The perception of color may depend on one of these factors, and intensity on the other. This problem need not concern one now. For the present purpose all one needs to know is that the intensity of the response of a cerebral unit is a function of the intensity of the stimulus reaching the unit.

To explain replacement the all-or-none law obviously requires that when the conscious unit receives a stimulus from one eye it excludes it from the other. From which eye it receives the stimulus must be controlled by some factor, and from the observations relating to the rod it seems safe to assume that this factor is attention, and one therefore now makes this assumption. Ignorance in regard to attention is no doubt commensurate with that in regard to all cerebral processes, but it is known that attention acts on every conscious perception. One knows that it is attracted by differences and changes of all kinds, including motion, and that the greater these are, the more strongly it is attracted. Attention may be diffused over all of one's perceptions, divided between any or all of them, or concentrated completely on the point of a needle.

It is generally assumed that attention may be voluntary, involuntary or both. The facts, however, may actually be that the action of attention is always involuntary, but the place or places in which it acts can be to some extent determined by the will. For one could easily direct one's attention to the spot on the wall, but the extent to which the rod then disappeared was entirely beyond the control of one's will.

Since different objects attract attention in different degrees, every object may be said to have attention value. One must then distinguish between actual attention value, which is the actual difference between the object and its surroundings, and effective attention value. One may therefore define effective attention value as the attention value of the stimulus for the perceiving mechanism concerned. The effective attention value depends on the extent to which the actual attention value can be perceived, and hence on the sensitiveness of the perceptive mechanism at the site of the stimulus. Thus in different persons the effective attention value differs according to the visual acuity, color perception, etc. In the same person it differs for different parts of the retina. In a normal person it will be highest in the fovea and progressively less toward the retinal periphery. No doubt the effective attention value may also differ in different parts of the brain. One can give one's complete attention to an object with a low effective attention value. An important factor in attention value is memory. This may either increase or diminish its value under different circumstances.

Usually effective attention value is dependent on so many varying factors that it cannot be measured. However, in the simple case of a uniform colorless straight line on a uniform white background, for many purposes the effective attention value of the line may be regarded as the difference between the effective intensity of the line and that of the background. But it must not be overlooked that the background itself has attention value. One must not also overlook the fact that value of any kind is always relative. If a line is perfectly black its effective attention value is the same as the effective intensity of the background. Effective attention value is not synonymous with visibility, because, as will be evident later, an image can be entirely invisible, that is to say not consciously recognizable, and yet have effective attention value somewhere in the brain. Obviously it would be absurd to speak of the visibility of an invisible image.

Let it now be inquired what occurs when a uniform white background is presented to both eyes at once. So long as the stimuli from the retinas remain constant the background must have a constant uniform appearance, since all of the conscious unit areas are constantly and equally stimulated no matter from which eye they are received. Presumably, however, since attention is not attracted to one field more than to the other, as many units will be represented from one as from the other. Suppose now one places a dark glass colorless screen before the right eye. Since this equally reduces the external stimulus on each retinal unit of this eye, it likewise equally reduces the intensity of the possible response of each conscious unit stimulated from the right eye. If, as in the present case, there is nothing in the background before one eye to attract more attention to it than to the background before

the other, there will be the same number of conscious units excited by one background as by the other, and the apparent intensity of the background as seen by both eyes will be a mean between the intensities of the two backgrounds. However, the sudden change produced by the interposition of the screen will at first attract more attention to the background before the right eye, so that the attention will permit more of the conscious units to be stimulated from the right than from the left eye and the conscious background will appear darker than the mean. Then as the attention fluctuates the intensity of the conscious background fluctuates and may become uneven in intensity. But soon it becomes relatively uniform and darker than it appears without the screen.

Let the screen now be removed and on the white background a black line be drawn to be seen only by the right eye. This will at once attract almost complete attention from its corresponding background before the left eye so that almost no stimuli from the latter will be permitted to reach the conscious units here concerned. The line at first will therefore appear almost perfectly black. Later, as attention fluctuates, it may appear lighter or uneven, or it may completely disappear if attention is given entirely to the corresponding background. If now one again places the screen before the right eye, the effective attention value of the black line must be reduced, and the value of the conscious background must also be reduced unless complete attention is given to the left retinal background. Under these conditions it might be thought that a white line should at times be seen in place of the screened line, since the area corresponding to the latter in the left eye is white. Repeated observations, however, show that the line completely disappears at times, but is never replaced by a line lighter than the background that is seen. If one removes the screen and draws before the left eye a line darker than its own background that will correspond to the black line before the right eye, but be lighter than the background of the latter, it is conceivable that by replacement a line lighter than its background could be seen, but repeated observations show that a line darker than its background is now always seen.

To explain why a white line or a gray line cannot be seen under the conditions specified, one must make the reasonable assumption that the same amount of attention is given to the homogeneous line as to its contiguous homogeneous background. From this assumption it follows that if in the conscious area concerned a certain proportion of the units of a retinal image are replaced, the same proportion of the units of its contiguous background must be replaced. Hence when a background is completely replaced, the image on it must also be completely replaced, and if each of two corresponding retinal images is darker than its background the conscious image must always be darker than its contiguous background. Only, therefore, when one of the corresponding retinal

images has a relation to its background the reverse of that of the other retinal image to its background can reversal of the relation between background and image occur in the conscious area. And only when one retinal background has no image, or when one corresponding homogeneous retinal image is lighter and the other darker than its own background, can the conscious image completely disappear, that is, become homogeneous with its background.

The process of replacement can be expressed algebraically as follows: Let B_l be the effective intensity of the left background, B_r that of the right background, B_c the intensity of the conscious background, I_l the effective intensity of the left retinal image, I_r the effective intensity of the right retinal image, I_c the intensity of the conscious image, A the total attention which is divided between the two retinal fields under observation, X the attention given to the left retinal field under observation and C the attention value of the conscious image.

$$\text{Then } B_c = XB_l + (A-X)\ B_r$$
$$\text{and } I_c = XI_l + (A-X)\ I_r$$
$$C = I_c - B_c = X\ (I_l - B_l) - (A-X)\ (I_r - B_r)$$

From this equation, assuming that effective retinal intensities correspond to actual intensities, by photometric measurements of the physical stimuli one can predict the limiting values and intermediate possibilities in the conscious area concerned. It is to be noted that $I_l - B_l$ and $I_r - B_r$ are the attention values of the two retinal images.

From the foregoing considerations it is obvious that replacement has the important restriction that it cannot reverse the relation of a homogeneous conscious image to its contiguous homogeneous background unless this reversed relation already exists between one of its retinal images and the background of the latter. Hereafter, by complete replacement will be meant replacement as complete as possible under this restriction.

The extent of the background that gives attention value to a homogeneous image can be observed in the following simple experiment: In the stereoscope a homogeneous dark gray circle with a black circumference is presented to one eye, and a corresponding white circle also with a black circumference, but with a small black dot in the center, is presented to the other eye. When the circles are unified there is seen a central dot surrounded by a zone lighter than the general background. This zone varies in size and has a diffuse outline, but is always perceptible so long as complete replacement does not occur.

That, as assumed in the foregoing discussion, a conscious image and its contiguous background are always actually replaced in the same proportions can be observed in a similar experiment.[3] A circular area

3. The details of this experiment were suggested to me by Dr. Z. W. Colson.

about 3 cm. in diameter, completely black except for a central white circular area 8 mm. in diameter, is presented to one eye, and a corresponding white circular area with a central black circular area 8 mm. in diameter is presented to the other eye. Then in the stereoscope it will be seen that the central area is completely black only when its contiguous background is white, and completely white only when its background is completely black, and that within the accuracy of observation, intermediate stages accord with the assumption made. This experiment also affords an excellent means of observing luster and of noting the conditions under which the latter is at its maximum.

One may now consider the question as to the possibility of binocular mixture of colors. If, in the case of monocular color vision, the mechanism were complete in each retinal cone with its conscious unit, binocular mixture identical with that of monocular mixture of colors would be impossible unless a special mechanism for fusion of color were assumed, for in binocular mixtures one would perceive at one time in varying proportions conscious units of one color and units of a different color, and how the total effect would be interpreted it is difficult to conjecture. On the other hand, if two or more cones were concerned in the process one might have exactly the same conditions obtaining in binocular as in monocular vision with one important exception, namely, that in binocular vision the differences in color between the conscious units would fluctuate with the attention. Observers who maintain, without assuming a special mechanism for fusion of colors, that under certain conditions binocular mixture identical with that of monocular mixture of colors is possible, must assume that more than one type of cone is concerned in the perception of color.

One may now consider the problem of binocular luster. If one looks at a uniform white background with a dark glass screen before the right eye, the background appears darker but shows no definite luster. This is evidently because the background is never sufficiently dark to make the phenomenon apparent. One cannot in this way obtain the best conditions for observing luster, namely, when one field is completely black and the other white, because to obtain this condition one will have to make the screen opaque and therefore one's attention will be attracted solely by the luminous field. Let one, then, without using any screen place a large black circular spot on the field to be seen by the right eye. This will attract one's complete attention so that luster will be impossible. Now let a circumference be drawn, to be seen by the left eye only, exactly corresponding to the circumference of the black spot. This attracts one's attention to the area it encloses and at times one sees a circle with exactly half the intensity of the surrounding background. Under these conditions one observes beautiful luster. Even if in place of the circle one employs a small dot to attract one's

attention to the white background, luster is elicited in the vicinity of the dot. Here, according to the theory, there are in the conscious area concerned a multitude of white dots intermingled with black dots, forming a mosaic of black and white dots too small to be recognized individually. Similarly there is a mosaic in the case of binocular luster that occurs when the two visual fields differ in color.

Now what does one see in the monocular perception of luster? If one looks at a piece of metal that has a rough surface one observes no luster. If one polishes the surface sufficiently one begins to see luster and the more one polishes it the greater the luster until finally one has made it into a mirror. It is obvious that the greatest luster has occurred when the surface has not been made smooth enough to act as a mirror and yet is smooth enough to reflect light strongly from a multitude of spots too small to be individually visible. It would seem, therefore, that binocular luster is exactly the same as monocular luster with the exception that the former fluctuates while the latter does not.

Having now, as it were, examined replacement from a microscopic point of view, one may in the light of one's findings again examine it from a macroscopic standpoint. If one defines, as one already has, a retinal point as a retinal unit, two corresponding points that are simultaneously stimulated cannot both be seen at once. But it is impossible actually to demonstrate this fact and the fact is of no practical importance, since it is impossible to confine a stimulus to such a small area of a retina as one unit. When one seems to see two corresponding retinal images as one, what is really seen is all of one, all of the other, or parts of one and parts of the other. If one sees a/b of that on the left, one sees $b\text{-}a/b$ of that on the right, in which a and b are variables that fluctuate with the attention. When the two images are nearly alike and constant in value, as they usually are when one looks at an object in space, the perceived image has nearly a constant value because the total stimulus perceived is always nearly the same. When the retinal images differ in intensity or color or in both, as they can be made to do in stereoscopic diagrams, the perceived image, that is, the conscious image, fluctuates in value but is never stronger than the stronger image or weaker than the other seen with one eye occluded. This constitutes the phenomenon known as rivalry. Rivalry and unification are thus simply special cases of the same phenomenon. In addition, as has been explained, when both images are partly seen a new quality may make its appearance, namely, binocular luster. The greater the difference between the images the greater the luster. For black and white, the maximum luster can occur only when one image is as black as possible and the other as white as possible. But luster does not necessarily occur under these conditions—it occurs only when both images are only partly seen and is at its maximum when, as seldom happens, each is seen in exactly half value.

"Suppression" is a term commonly used to explain the disappearance of an image from consciousness and also to explain rivalry. Whatever this term may mean, it fails in my opinion to explain or describe these phenomena adequately, because it does not imply that when one image disappears another must take its place. The term "replacement," it seems to me, should therefore be employed instead. For rivalry the term "reciprocating replacement" seems descriptive. Every retinal image has its substitute, that is, its corresponding image, that can in the brain take its place in whole or in part at any time. Within the restriction previously noted, it is now known that replacement may be to any extent complete or incomplete, that it may involve a large field or be confined to the smallest perceptible area in the binocular field. The area involved may be sharply defined or diffuse. The sharpness of its demarcation is limited only by the visual acuity. When reciprocating (rivalry) it may be slow or rapid. The extent and frequency of rivalry are due to fluctuations in attention, but the exact causes of the fluctuations remain problems for investigation. However, it is evident that the retinal images or the parts of retinal images with the higher attention values are the ones that are first seen, and it seems that their subsequent replacement is usually due to reduction in their effective attention values by nonretinal fatigue or something allied to it.

It was stated earlier that corresponding images must appear to coincide. From a microscopic standpoint, however, it is obvious that the conscious representations of retinal images cannot actually coincide. For only one of each pair of corresponding retinal units can be represented in consciousness at one time. Hence corresponding retinal images coincide in consciousness only in the sense that two duplicate picture puzzles coincide when parts of one are substituted for corresponding parts of the other. Unification, as it actually occurs, requires replacement, complete or incomplete, whereas fusion, as ordinarily understood, cannot occur when there is complete suppression. Fusion is commonly not distinguished from binocular fixation in spite of the fact that it is held that the former may exist without the latter. In a normal person true unification of two retinal images necessitates their binocular fixation, since they must correspond, and conversely, binocular fixation necessitates unification.

Stereogram 1 illustrates one condition in which the phenomenon of replacement is extremely sharp, usually complete and almost constant. When the two lines are unified, the gaps are as plainly seen as when the lines are viewed monocularly—the image of the white paper in each gap has been substituted for the image of the corresponding place in the other line. The smaller the gaps are made, the more constant and complete the replacement and the less the latter is affected by the usual ocular dominance. This is demonstrated by the fact that the replacement

is usually the same in all the gaps, some of which are seen with the right eye, the others with the left eye. Here, regardless of the usual ocular dominance, one eye is dominant for some places in the binocular field and the other eye for other places. This experiment clearly shows that

Stereogram 1

Stereogram 2

Stereogram 3

Stereograms 1, 2 and 3 should be cut out and viewed in a stereoscope.

replacement is controlled by attention, and that attention is here attracted by abrupt dissimilarity. It also shows that one can voluntarily direct one's attention to a particular place in the visual field but that one cannot control the replacement in this place. For one cannot by any effort of the will make any of the gaps appear or disappear. This is true even when it has been ascertained by closing one eye to which eye each gap

belongs, and its exact position, and attention has been directed to any one of the gaps.

An interval of time is of course necessary for replacement to take place, but at present I know of no method by which the minimum interval can be determined. A simple experiment, however, shows that the interval may be so short that it cannot be consciously recognized. If attention is directed to one of the gaps in stereogram 1 and then the corresponding eye is suddenly screened with a white screen, the gap appears to be instantly filled by the black line. One is not conscious that any time elapses before one sees the gap filled in. Similarly, if one then raises the screen so that one can fix the unified line just below the gap and then suddenly removes the screen, the gap appears to be instantly seen. The persistence of retinal processes no doubt will always defeat one's purpose if one attempts to make determinations more accurate than this. Replacement of a visible area may be slow, however, since its rate depends not solely on that of each conscious unit, but also on the number and distribution of the conscious units concerned in the replacement and on the frequency with which they are replaced.

Ocular dominance, as ordinarily understood, probably has both a sensory and a motor basis. On the sensory side it is explained by replacement, if one assumes an inequality in the stimuli that reach the cerebral area in which unification occurs. This inequality may be dependent on defects in the optical system or in the nervous mechanism, including the retina. This assumption is substantiated by the fact that sensory dominance can usually be reversed by means of a dark glass screen.

It is commonly believed that if one looks at an object with both eyes open and then with one eye closed one has compared monocular and binocular vision. In reality this is not the case, because one has not in this way certainly excluded binocular vision—in fact, there is no way in which to do so. Even when all light is excluded from one eye, sensations of light and even of form are being sent to the brain by this eye, and there may always be sensations pertaining to this eye which arise in the brain itself. In fact, it is known that under certain pathologic conditions visual sensations originate in the brain. Differences, especially as regard intensity, that one may detect between the aspects of an object when seen binocularly and with one eye screened may be due partly or wholly to the screened eye. One also cannot compare with exactness the retinal image in one eye with that in the other, for as soon as one occludes one eye it is undergoing dark adaptation while the other is being fatigued. Then, too, when one produces diplopia of an object, as is necessary to compare the images, the two retinal images do not afford an accurate means of comparison because they are on non-corresponding points. In spite of these insurmountable difficulties the

image of an object seen binocularly often appears so nearly like that seen when one eye is screened that one cannot ordinarily detect any difference. Actually, however, experiments have indicated that the binocular image is perceived more strongly than the monocular, and that the minimum visible intensity may be slightly less for two eyes than when one eye is screened or its image excluded in an analogous way. This is easily explained by replacement. For even when one eye is screened there remains, as just pointed out, some stimulus arising from the eye itself. This is always less than that from the other eye, because the other eye has an external stimulus in addition. Thus when both eyes are used the stimulus perceived by the brain can never be less than the stimulus from each eye, namely the external stimulus plus the stimuli arising from the eye itself. When one eye is screened, however, the stimulus perceived may often be less, because for a fraction of this stimulus the same portion of the weaker stimulus from the screened eye may be substituted, thus making weaker the total stimulus to be perceived. In other words, if an object has a constant intensity and the eyes are equal, the conscious image of the object in the case of binocular vision will, as previously explained, maintain a constant value. When one eye is screened, the conscious image may at times attain this value, but owing to the phenomenon of replacement may often fall below it.

Other factors, possibly still more important, in causing a field to appear more intense when seen with both eyes than when with one, are inequalities in the response and in the fatigue within each retinal field. That such inequalities exist becomes very evident in the observation of monocular flicker. Since the conscious field is generally supplied by those parts of each retinal field that have the higher intensities, its average intensity is therefore usually higher in binocular vision than when one eye is occluded. No doubt the foregoing considerations explain why different investigators have obtained such different results when attacking this problem.

Sherrington's explanation [4] of the seeing of two corresponding retinal images as one seems to me vague and unconvincing. It amounts to little more than the statement that the images are seen as one in spite of their separate representations in the brain. He admitted that "the cerebral seats of right and left eye visual images" were "no doubt interconnected by conductive paths," but he refused to attribute any sensory significance to this fact. Briefly, his rejection of a common cerebral representation of each pair of corresponding retinal areas was based on the assumption that if such representation existed, alternate binocular flicker would be abolished when the rate of alternation between the two

4. Sherrington, C. S.: On Binocular Flicker and the Correlation of Activity of Corresponding Retinal Points, Brit. J. M. Psychol. **1**:26, 1904; The Integrative Action of the Nervous System, New Haven, Conn., Yale University Press, 1911.

eyes was the same as the rate of presentation to one eye required to abolish monocular flicker, whereas his experiments showed that binocular flicker required about twice this rate for its extinction. But for this deduction to be valid the assumption is necessary that flicker must be abolished in the brain at the same rate at which it is abolished in the retina. Since there is no evidence to support this assumption, and it is a priori improbable, his experiments actually have no bearing on the question of the cerebral representations of the retinas. Although they have commonly been regarded, notably by Duke-Elder,[5] as of great significance in this connection, they in all probability indicate only that flicker is abolished in the retina before it can be abolished in the brain.

On the theory of replacement all of Sherrington's observations relating to binocular flicker are consistent with the unitary cerebral representation which he rejects. According to this theory, such slight differences as exist between monocular and binocular flicker are due to rivalry which in turn is due to fluctuations in attention. In alternate binocular flicker there should be areas of flicker arising from one eye intermingled with areas of flicker from the other eye. The sizes and distributions of these areas would be dependent on rivalry and hence primarily on the effective attention values of different areas in the field. Owing to inequalities in retinal fatigue, and other conditions, these effective attention values would differ from each other and change irregularly even in the case of a uniform field. Since flicker from one eye alternates with that from the other, the flickering would often appear to be twice as rapid as when seen with one eye occluded, and the changes in intensity half as great. Under certain conditions, namely when the rate was within a certain range, and the fields from the two eyes were evenly and about equally represented in the conscious field, binocular flicker would disappear, although it would still be well marked when either eye was occluded. The smaller the field the more readily these conditions could be obtained, since replacement is apt to be more uniform in a small than in a large field. Actual observations on binocular flicker that I have made, including some made through colored screens, confirm these deductions from the theory of replacement. The latter are also in accord with Sherrington's findings so far as he described them, but he did not describe the apparent rapidity of binocular as compared with monocular flicker. On the theory of replacement it might be possible to obtain conditions under which binocular flickering would appear to be about twice as rapid as the rate needed to abolish monocular flicker, but thus far I have been unable to do so definitely. The difficulty here lies in the facts that the intensity change in the flickering becomes so slight

5. Duke-Elder, W. S.: Text Book of Ophthalmology, London, Henry Kimpton, 1932, vol. 1, p. 1035.

and the rapidity so great that the visible rate cannot be estimated with sufficient accuracy. If this difficulty could be overcome, it would no doubt be possible to demonstrate that the brain can perceive an alternation of visual stimuli more rapid than can be sent by one retina.

One may now consider what takes place when the retinal images of an object fall on points that are laterally disparate. If one fixes binocularly a point in a view, the images of a multitude of objects in the view will fall on noncorresponding retinal areas. But each of these retinal areas in one retina has its corresponding area in the other retina, and this is usually occupied by some sort of an image. Thus if *a* and *b* are two disparate images of an object, then there is usually an image *c* that corresponds to *b*. If, as rarely happens, *c* is similar to *b*, then *c* and *b* will be projected unified on the horopter, and *b* will produce the same effect of depth on *a* as if there were no image at *c*. If in addition there is an image, *d*, that corresponds to *a*, then even if *c* and *d* are both considerably less intense than *a* and *b*, the latter are both seen on the horopter. These phenomena are easily observed when suitable stereoscopic diagrams are used. As a rule, however, each disparate image is markedly different from its substitute, and when visible is seen in depth. The wider the disparateness between two similar images the more likely that both will be seen, but many normal persons have never perceived physiologic diplopia under any ordinary conditions. Failure to see two disparate images as two when they produce the effect of depth is commonly said to be due to fusion of images lying on noncorresponding points, and Panum has assumed that there are areas in which this fusion of images can take place. I believe that this conception is entirely erroneous and that no such areas exist in the sense indicated. For true unification of disparate images such as occurs in the case of corresponding images cannot take place. When it seems to occur, what actually happens is that one of the disparate images is completely replaced by its substitute and disappears from consciousness. As explained subsequently, when disparate images produce an effect of depth, one of them is usually thus invisible. This apparent unification of disparate images that takes place when there is stereopsis may be termed "quasi-unification." But even if in the definition of Panum's areas this term is substituted for "fusion," the conception still remains of no significance, since there are no definite limits beyond which quasi-unification is impossible.

The next question that arises is: How do disparate images give rise to the perception of depth? A complete discussion of this complex question does not come within the scope of the present communication, but I shall try to point out some of the important factors concerned. It involves the question of the motor mechanism of the eyes and that of the horopter, but I shall not discuss these here.

Let one of the simplest stereoscopic perceptions be considered, that of a line slanting fore and aft. On a white cardboard suitable for use in a stereoscope, let a circle be drawn to be seen by the right eye, and a corresponding circle to be seen by the left eye (stereogram 2). Then through the right circle let a diameter be drawn with its upper end inclined to the right, and through the left circle a diameter inclined an equal amount to the left. Through the stereoscope, if the angular disparateness is not too great, a single line slanting fore and aft will now be seen. The amount of this slant I shall not discuss in the present communication. If the attention is directed to the center of the circle, the line may appear single only near the center and double toward the periphery, but whether seen single or double, the fore and aft slant will appear to be the same. The fact that perception of depth may still occur when disparate images are seen as two and no movement and rivalry are perceptible [6] disproves the theory recently advanced by Washburn.[7] With fixation on the center of the circle steadily maintained, most observers will see a single line nearly but not exactly in the vertical midplane. By vertical midplane I mean an imaginary midplane that would bisect the angle between the two disparate images if both were seen at once. If for any reason, for instance, oblique astigmatism or torsional deviation, the observer's judgment of the vertical is incorrect, this might not correspond to the actual midplane. In the case of an observer who has a strongly dominant eye, the line will always point with reference to the midplane upper end slightly toward this eye. In others it will alternately point toward one and then the other eye. Moreover, the upper and lower parts of the line may at times point in opposite lateral directions, so that the line is no longer a true diameter. If binocular fixation is allowed free play, the line may appear to be in the midplane because each of the successive points of fixation then appears to be in the midplane. The important fact is that the line appears to change its position at times when fixation on the center of the circle is maintained. What has happened here?

In the first place, the line seen obviously corresponds in position to neither of the lines on the cardboard, but is displaced toward the midplane. It changes its position when either eye is screened. It actually corresponds, however, to one of the lines that has been displaced both laterally and fore and aft from its actual position—the other line has

6. von Kries, in von Helmholtz, H. L. F.: Treatise on Physiological Optics, translated by James P. C. Southall, Ithaca, N. Y., Optical Society of America, 1924-1925, vol. 3, p. 396. Tschermak, A., and Hoefer, P.: Ueber binoculare Tiefenwahrnehmung auf Grund von Doppelbildern, Arch. f. d. ges. Physiol. **98**: 299, 1903.

7. Washburn, M. F.: Retinal Rivalry as a Neglected Factor in Stereoscopic Vision, Proc. Nat. Acad. Sc. **19**:773, 1933.

completely disappeared except near the center of the circle where the two images overlap and hence are on corresponding points. In the disappearance of one line what has happened is that there has been substituted for the retinal image of this line the image of the portion of the cardboard that corresponds to it in the other eye.

If now in the circle on the left one draws a solid radius exactly corresponding to the upper half of the diameter in the circle on the right (stereogram 3), in the stereoscope one sees a radius in the plane of the cardboard and a diameter with the same fore and aft slant and position it had in the previous experiment. If exact fixation on the radius is maintained, the upper half of the diameter will have a fixed position, because the only disparate image ever seen is that belonging to the left eye. Its fellow has disappeared by unifying with the radius. The lower half of the diameter, however, behaves exactly as it did in the previous experiment, sometimes therefore appearing to make a slight angle with the upper half. The fact that the gap in the diameter before the right eye is seen only on the radius when the figures are viewed in the stereoscope with exact fixation proves without doubt that the diameter before the left eye, although it shows the same depth as in the previous experiment, has not "fused" with the diameter before the right eye. The two markers in the diagram are to assist the observer in determining whether or not he is maintaining exact fixation.

Stereogram 1 shows in a striking manner that one disparate image may completely disappear and yet produce an effect of depth on other disparate images. In the large middle gap the line completely disappears as it does in all the other gaps, while when there is perfect stereopsis the two short parallel lines seen by the left eye appear one in front of and the other behind the main line. To remove any doubt that the line before the right eye disappears in the gap, it may be replaced by a continuous red line in the diagram for the right eye. When rivalry appears in the upper part of the unified line, it sometimes appears red, but the two short parallel lines never appear red. Occasionally a red line will flash out between the latter, but it never coincides with either unless the fixation is changed. The lower part of the stereogram shows in similar fashion that a line can disappear, that is, can be completely replaced by the white background, and yet affect the apparent depth of four other lines. I have obtained the same phenomenon with as many as eight lines.

The exact amount of the lateral displacement of the disparate images in the foregoing experiments is difficult to determine. To ascertain this it is necessary to compare monocular impressions with stereoscopic impressions. If, when viewing a stereoscopic diagram, one eye is suddenly occluded, there is nothing to counteract the stereoscopic impression, and this often persists for a relatively long time. When the eye

is unscreened, however, and binocular fixation has not been lost, an effect of depth may be instantly perceived. From a study of stereoscopic diagrams such as stereograms 2 and 3 and many others modified in various ways, the impression that I have obtained is that the amount of lateral separation between disparate images that is apparent when there is an effect of depth is approximately half that seen when there is no effect of depth.[8] In any case I am certain that in stereoscopic vision disparate images are never displaced toward each other to such an extent that they coincide in position. They appear to coincide only when binocular fixation is allowed free play and the disparateness is thus actually abolished at the different points of fixation. The slighter the disparateness the more difficult it is to control fixation and hence the more likely that the disparate images will appear to coincide.

As regards vertical disparateness, so far as I have been able to determine by means of stereoscopic diagrams, purely vertical disparateness of itself has the same effect as if both the images were from the same eye. If, however, with the vertical disparateness there is a component of lateral disparateness, there is an effect both of depth and of apparent reduction in vertical distance between the disparate images. This is evident when a horizontal straight line seems to unify with a curved line.

It is important to note that binocular fixation can take place when one of the disparate images to be fixed is invisible. For in stereogram 1 binocular fixation can readily be transferred from the main line just above the circle, to any one of the parallel lines, each of which at the outset is disparate with reference to the invisible line with which it undergoes fixation. Since in ordinary vision one of each pair of disparate images is invisible, this phenomenon is a usual feature of binocular fixation. Moreover, since in rivalry one image sometimes disappears, it is evident also that binocular fixation can be maintained while one corresponding image is invisible. The latter fact can be demonstrated by the following experiment. If on a uniform white background a black line is presented to the right eye, and another line exactly similar is presented to the left eye, before which there is a dark glass screen, and the eyes are converged until both lines are seen, then on slowly relaxing the convergence, the dim line may be seen to disappear completely just before it can go into the other line. If the screen is placed before the right eye, the line belonging to this eye disappears. Moreover, the line that remains appears no weaker and at times appears even more intense than it was before, since it is no longer replaced to any

8. In discussing the cyclopean eye, Le Conte (Sight, ed. 2, New York, D. Appleton & Company, 1897, p. 248) and other observers have not taken into consideration this apparent displacement of disparate images that occurs in stereoscopic vision.

extent by the white background. If the unscreened eye is suddenly occluded, the dim line is seen in exactly the same place as the strong line, showing that binocular fixation has been maintained. Moreover, if the eyes are converged the dim line can be seen to emerge from the strong line without altering the intensity of the latter. Similar observations can be made by making the line before the right eye green and that before the left eye red, and retaining the dark screen before the right eye. Then the intensity and color of the red line are usually not recognizably altered when the two lines are unified. To prove that fixation is being maintained, two markers may be employed as in stereograms 2 and 3. The density of the dark glass screen and the intensity of the illumination must be suitably adjusted, but this is not a difficult matter. It seems evident from these and many other observations that in binocular fixation the different parts of an object as represented in its conscious image are usually supplied only by the eye that sees them the more distinctly. This explains why it is that visual acuity may be higher in binocular than in monocular vision, since in all persons the optical imperfections must be to some extent asymmetrical.

It is also important to note that when one sees two heteronymous images it seems to one that the image on the right belongs to the right eye. This shows that one cannot consciously distinguish crossed from uncrossed disparate images. Yet the mechanism for stereoscopic perception of depth, when in action, instantly and unerringly makes this distinction if the disparateness is not exceedingly great or exceedingly slight. The following observation shows not only that consciousness cannot distinguish between homonymous and heteronymous images, but in addition shows that binocular fixation is in consciousness, at least, controlled by the idea of depth, whether this idea has been generated by disparate images or by monocular perspective. For in binocular simultaneous vision, such, for example, as occurs when monocular perspective prevails during the use of a pseudoscope, I have frequently observed that in the attempt to bring widely disparate homonymous images into central fixation further convergence occurs, thus increasing the disparateness.

Moreover, even in the case of two corresponding images one is not consciously aware to which eye either image belongs. This is true even when the stimuli are entirely different, for instance one red and the other green, since in the rivalry that ensues one does not know from which eye either color arises. It is demonstrated also by the fact that in the stereoscope one does not know to which eye any one of the gaps in stereogram 1 belongs. Nevertheless, somewhere in the brain corresponding retinal images are distinguished from each other. For let *a* be an image in the right retina and *c* another image to the left of it, and *b* the substitute for *a*, and *d* the substitute for *c* in the left eye,

then *a* and *d* are heteronymous, and *c* and *b* homonymous disparate images. Since the brain can recognize these relationships, it must have determined to which eye each of the four retinal images belongs and therefore has recognized that *a* belongs to the right and *b* to the left eye. In other words, since *a* and *b* are corresponding images, somewhere in the brain corresponding retinal areas must be represented separately, and therefore the theory of identity as ordinarily understood is erroneous. There are good reasons to believe that in the occipital lobes corresponding retinal areas are represented anatomically in close apposition but yet separately,[9] and it seems, therefore, that here corresponding retinal images are distinguished from each other, and that possibly here is situated, at least in part, the mechanism for stereoscopic vision.

In ordinary vision, the factors that cause one image to disappear, or rather not to be seen, are probably various, but no doubt the most important are the effective attention values of the images and their substitutes. As has been pointed out, when an image completely replaces its substitute, its contiguous background also completely replaces the substitute of the latter. Hence if disparate images encroach on each other's contiguous backgrounds, and one image is completely seen, its background must completely replace the other image. This no doubt explains why even in the use of stereoscopic diagrams quasi-unification more readily occurs in the case of slightly than of widely disparate images. In the use of such diagrams, and in ordinary vision, if the backgrounds have of themselves little or no attention value, disparate images may alternately disappear as in rivalry.

If the substitutes of disparate images both have higher attention values than the images, both of the latter may disappear. If there is a difference in the visual acuities of the two eyes, the less distinct image generally disappears. If the two eyes are nearly equal, the image nearer the fovea will have the higher effective attention value. Even, however, when a disparate image passes through the fovea it will be invisible if its substitute, that is, the corresponding part of the field belonging to the other eye, has a higher attention value than the image in question.

On account of their simplicity and convenience, stereoscopic diagrams have been employed in most of the experiments described. There are occasional observers, however, with perfect stereoscopic vision under ordinary conditions, who have great difficulty in recognizing depth under the artificial conditions that obtain in the use of a stereoscope. Here evidently there is conflict between monocular and stereoscopic perception and also often difficulty in dissociating convergence from accommo-

9. Henschen, S. E.: On the Visual Path and Center, Brain **16**:179, 1893; Zur Anatomie der Sehbahn und des Sehzentrums, Arch. f. Ophth. **117**:403, 1926; Die Vertretung der beiden Augen in der Sehbahn und in der Sehrinde, ibid., p. 419.

dation. For such observers it is possible to construct actual objects to replace the diagrams. Stereogram 2 can be replaced by an actual slanting rod. The phenomena shown by stereograms 1 and 3 can be duplicated by the use of actual objects and suitable screens, but it is extremely difficult to construct and place the screens correctly. Many persons have little control over binocular central fixation, and since it is essential that the latter be relatively accurate in the experiments, such persons may have great difficulty in observing the phenomena described. Moreover, since a retinal image may persist for at least one tenth of a second, it is even possible that to some observers it may sometimes appear that one retinal image coincides with two retinal images in the other eye.

In my paper of thirty-five years ago on stereoscopic vision [10] I stated that I could sometimes see three images of a slanting line. Since then I have repeatedly confirmed this observation and have encountered several other observers who also could do so. At that time I accepted the notion, now still prevailing, that disparate images can be fused, and explained the three images on the assumption that under certain conditions the monocular images and the "fused" stereoscopic image of the line could be seen at one time. On the basis of the present theory the explanation is somewhat different. If fixation is maintained as steadily as possible on one end of a slanting line in the midplane, the two retinal images of the line are only slightly disparate near the fixation point and one of them usually disappears here, thus giving the impression of fusion. At the ends of the line the images are widely disparate and may often be seen double. The double images at times are seen in depth, at other times without depth (binocular simultaneous vision). In the latter case they appear to be farther apart than in the former. Between the single image and the double images there is an interval of varying width in which at times, probably due to persistence of alternating impressions and wavering of fixation, all three images seem to be present at the same level. On continuing the observation, one of the double images may disappear and its fellow may or may not appear to be the continuation of the portion of the line near the fixation point. Such observations, of course, are usually beyond the scope of novices.

In a previous communication [11] I have shown that when the luminosity of one disparate retinal image, *A*, is reduced below that of the other retinal image, *B*, the effect on the apparent position of the object as regards lateral displacement and depth is the same as would result

10. Verhoeff, F. H.: A Theory of Binocular Perspective, Ann. Ophth. **11**:201 (April) 1902; republished with corrections in Am. J. Physiol. Optics **6**:416 (Sept.) 1925.

11. Verhoeff, F. H.: Effect on Stereopsis Produced by Disparate Retinal Images of Different Luminosities, Arch. Ophth. **10**:640 (Nov.) 1933.

from a displacement of *A* toward *B* when their luminosities were equal. This effect is directly proportional to the amount of disparateness. For a decided effect to be produced, however, the reduction in luminosity must be very great—to reduce the effective disparateness about one fourth, the luminosity must be reduced 80 per cent. In these experiments black lines on a white background were employed, and the luminosity of the background was regarded as the luminosity of the image. The theory of replacement throws a new light on this phenomenon. In the experiments when the dark glass screen was placed before one eye it reduced the effective attention value and caused the disparate image belonging to this eye to disappear. Hence the effects observed were solely those produced on the image from the unscreened eye. The question therefore arises as to what the effect on the dimmed image would be if this was made visible. As a matter of fact it is possible to make this image visible by increasing its attention value in some other way than by change in its luminosity. Thus if, when viewing stereogram 3, a dark glass screen is placed before the left eye so as to obstruct the upper half of the figure for this eye, one usually sees the upper half of the diameter as a dim line. By repeatedly removing and replacing the screen one ascertains that when the screen is in position the maximum depth effect on this line is increased and the line is rotated farther toward the midline. On the other hand, when the screen is placed before the right eye, these effects are diminished as already described. It seems, therefore, as might be expected, that when two disparate retinal images are made markedly unequal in luminosity, the effects of the weaker image on the stronger, as regards depth and lateral displacement, are diminished and those of the stronger image on the weaker enhanced. When images are so greatly disparate that both can easily be seen when the screen is placed before one eye, the rivalry between monocular and stereoscopic vision that ensues makes interpretation of the observations difficult.

It will be seen that according to this theory binocular vision is carried out by cerebral processes that act in at least two levels, the subconscious and the conscious. Just where these levels are located there is as yet insufficient knowledge to determine, but present information suggests that the subconscious level is in the occipital lobes, and the conscious level in one or both of the frontal lobes. In the subconscious level corresponding retinal images are represented separately but are not here consciously recognized. In the conscious level there is only one area for each pair of corresponding images, and what parts of the two images occupy this area at a given time are determined by the process of replacement, controlled by the attention, as has been explained. When a conscious image is entirely replaced and thus becomes invisible, its representative in the subconscious level is unaffected. Disparate images in

the subconscious level interact so as to produce an effect which is transmitted to the conscious level and is there perceived as depth and referred to the conscious representatives of the images concerned. If a disparate image has been excluded from representation in the conscious level, that is to say, is invisible, the effect on its visible fellow as regards depth and position is not thereby altered. Binocular fixation is carried out by two motor mechanisms, a voluntary and an involuntary. The latter is entirely controlled by the images in the subconscious level, and probably on it duction power chiefly depends. The voluntary mechanism is activated by the sense of depth, however derived, whether from the subconscious level stereoscopically or from monocular factors or from both. Hence either mechanism can act when one of the images to be fixed is invisible.

One may now conclude that in stereoscopic vision information in regard to the position of an object relative to the horopter is sent to consciousness by a subconscious mechanism. Other information as to the position of the object, however, is also sent to consciousness, notably that derived from the many factors that determine monocular perspective. Consciousness can accept or reject any or all of this information. If the information is conflicting, that which seems most reliable is accepted, but the contrary information may cause doubt. One knows that the wider the disparateness of retinal images, the weaker the impression on consciousness, although the greater the depth indicated. Hence the wider the disparateness the more apt is the information it furnishes to be rejected. In the case of stereoscopic diagrams this information is especially apt to be rejected, because here one knows that the objects seen are actually in the plane of the cardboard. Moreover, one may reject the stereoscopic information for one disparate image and accept it for the other. When one views any sort of a picture, photograph or moving picture, one habitually rejects stereoscopic information. For the latter tells one that all the objects are in the plane on which the picture lies. Then again, if one substitutes two identical pictures for two stereoscopic pictures, one can superimpose simple stereoscopic figures on them whose effect of depth in the stereoscope will be less than that of the monocular perspective. In the case of pseudoscopic vision, the stereoscopic information from widely disparate images is almost always rejected, since the information furnished by monocular perspective accords with previous experience. For convenience, one may distinguish between stereoscopic vision and binocular simultaneous vision. Both types of vision can occur at the same time, but each in a different part of the visual field. In general, when stereoscopic information relating to any disparate images is rejected, the retinal images concerned that are not replaced are projected monocularly.

Finally the question arises as to the relation of the two theories of vision, the nativistic and the empiristic, to the theory which has been arrived at here. According to this theory there must be an anatomic relation between corresponding retinal points that gives rise to their functional relation and that necessitates single vision as soon as binocular fixation is achieved. Therefore correspondence of retinal points must be congenital in origin. To substantiate their empiristic views, von Graefe,[12] Donders,[13] von Helmholtz and others, including Sherrington, have pointed to the cases of strabismus with anomalous diplopia as indicating that retinal points not congenitally corresponding can serve for single vision. But in a typical case of this kind I demonstrated thirty-three years ago that the supposed false macula changed its distance from the real macula more than 15 prism-diopters when the patient looked first at a distant and then at a near object, and that the patient had no stereoscopic vision, thus proving conclusively that the projection in such cases is not analogous to that based on the retinal correspondence of normal persons.[14] One may say, then, that as regards unification the theory of replacement is strictly nativistic. As regards perception of depth it is also nativistic in its assumption that the unconscious sensory mechanism for this perception is developed without the aid of experience, but it is empiristic in its assumption that experience may be required for consciousness fully to evaluate the information sent to it by this mechanism.

SUMMARY AND CONCLUSIONS

Corresponding retinal units are represented separately somewhere in the brain, but each of every pair is represented in consciousness by the same single unit. This conscious unit can receive the stimulus from only one retinal unit at a time; when it receives the stimulus from one it excludes the stimulus from the corresponding unit. For the process by which, in consciousness, stimuli from one eye are thus substituted for those from the other, the term "replacement" is suggested. The controlling factor in this process is attention. For individual retinal units replacement is always totally complete, but for retinal images it may be complete or incomplete, according to the number and distribution of the unit stimuli from one eye that are completely excluded. Replacement has one important restriction, namely, that it cannot reverse the rela-

12. von Graefe, A.: Ueber das Doppelsehen nach Schiel-Operationen und Incongruenz der Netzhäute, Arch. f. Ophth. **1**:82, 1854; especially pp. 95 and 96.

13. Donders, F. C.: On the Anomalies of Accommodation and Refraction of the Eye, translated by W. D. Moore, London, New Sydenham Society, 1864, p. 165.

14. Verhoeff, F. H.: Theory of the Vicarious Fovea Erroneous, Ophth. Rec. **10**:300 (June) 1901.

tion of a conscious image to its contiguous background unless this reversed relation already exists between one of the retinal images and its own background.

For the seeing of two corresponding images as one, the term "unification" is suggested. The terms "fusion" and "suppression," as applied to vision, are misnomers and should be abandoned.

True unification is accomplished by the complete or partial replacement in the conscious image of one retinal image by its corresponding image. When the two retinal images are nearly alike, the conscious image has a nearly constant value which is nearly the same as that of each retinal image seen with one eye occluded. When the two retinal images differ in intensity or color, the attention and therefore the replacement may fluctuate (rivalry). It is impossible to compare accurately a binocular with a monocular image, because it is impossible certainly to exclude binocular vision.

So-called fusion of disparate retinal images does not occur, but seems to occur when two similar disparate images produce the effect of depth and one of them disappears by replacement. It is suggested that this process be termed "quasi unification." In the stereoscopic perception of depth, quasi-unification generally occurs, but depth perception is possible when both of any pair of disparate images are visible. Two disparate images, as projected on the horopter, appear about half the distance apart when seen stereoscopically as they do when seen in binocular simultaneous vision. When a disparate image disappears during stereopsis, the position of its fellow remains unchanged. Which of two disparate images disappears is primarily determined chiefly by the effective attention values of the images and of the portions of the backgrounds corresponding to the latter.

Binocular luster is produced when, as the result of replacement, there is represented in a conscious area a mosaic consisting of units or minute areas of high intensity interspersed with areas of low intensity. It differs essentially from monocular luster only in the fact that it is inconstant.

Since in stereoscopic vision one of each pair of disparate images can be and generally is invisible, since crossed cannot be consciously distinguished from uncrossed disparate images, and since binocular fixation can occur when one of the images fixed is invisible, it is evident that the process on which stereoscopic perception of depth depends cannot be consciously recognized.

Since somewhere in the brain corresponding retinal images must be represented separately, and there is good reason to believe that in the occipital lobes they are so represented, it seems possible that in this region is chiefly situated the sensory nervous mechanism for stereoscopic perception of depth.

THE NEMATODE THELAZIA CALIFORNIENSIS AS A PARASITE OF THE EYE OF MAN IN CALIFORNIA

CHARLES A. KOFOID, PH.D., SC.D.
BERKELEY, CALIF.
AND
OWEN L. WILLIAMS, PH.D.
STOCKTON, CALIF.

Nematodes of the genus Thelazia occur as natural parasites in the conjunctival sac and on the surface of the eyeball of certain mammals and birds in various parts of the world. Rarely, and probably abnormally, the human eye is parasitized with nematodes of this genus. Up to the present time only four cases of infestation of the human eye are on record, all of these reported from China.

SUMMARY OF FOUR CASES RECORDED PREVIOUSLY

CASE 1.—A Chinaman, aged 25, with relatively slight symptoms, had six worms removed from the right eye. The case was reported by Stuckey.[1]

CASE 2.—A Chinaman had severe symptoms; he had marked ectropion of the right eye and excessive lacrimation; he was very nearly dismissed as having incurable facial paralysis. Two worms were removed from the right eye. The case was reported by Trimble.[2]

CASE 3.—A Canadian missionary in China, a man aged 52, had a wartlike papilloma of long standing on the lower right eyelid, which became infected with larval thelaziasis causing irritation. The case was reported by Howard.[3]

CASE 4.—A Chinese boy, aged about 10, had sixteen specimens removed from the eye. The clinical data were scant. The case was reported by Hsü.[4]

In these four cases the specimens obtained were examined by various parasitologists and finally identified as Thelazia callipaeda, a normal parasite of the eyes of dogs in India and China.

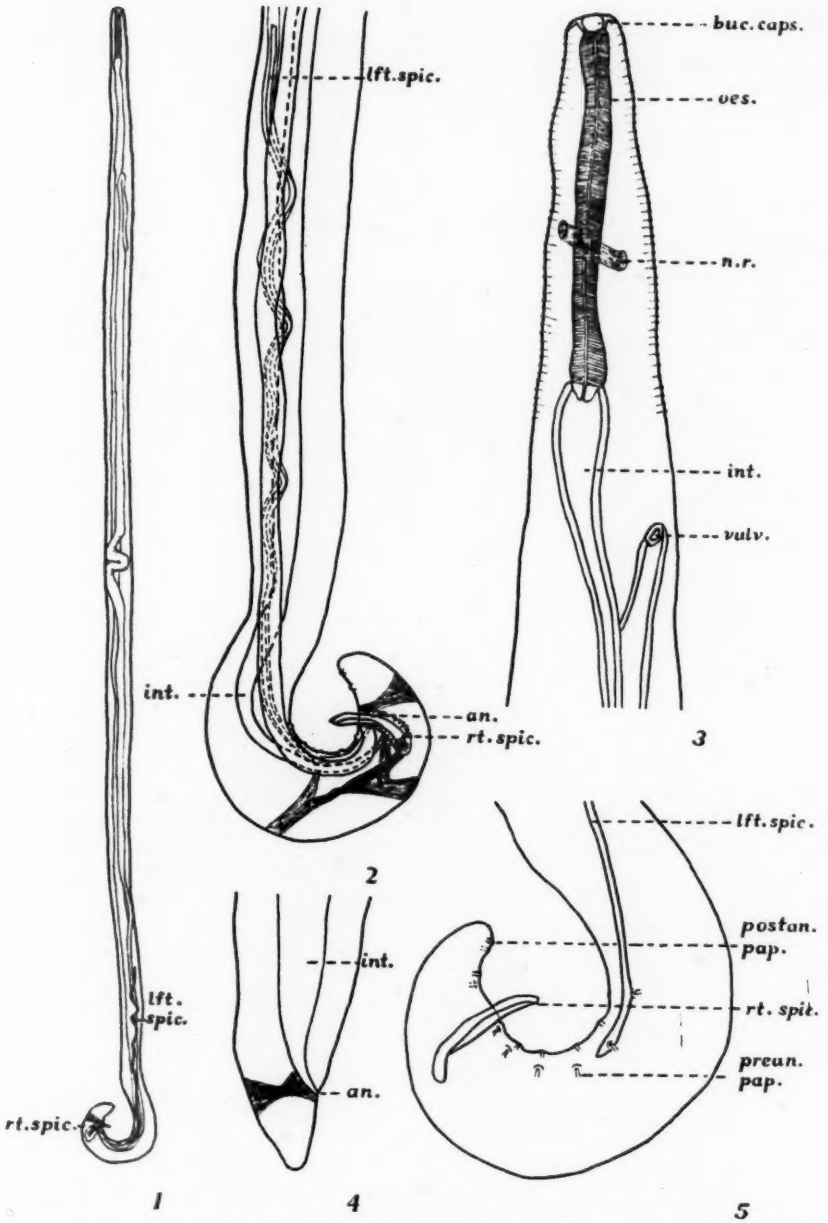
From the Department of Zoology, University of California, and the Department of Biologic Sciences, College of the Pacific.

1. Stuckey, E. J.: Circumocular Filariasis, China M. J. **31**:24, 1917; one plate.

2. Trimble, C. G.: Circumocular Filariasis, China M. J. **31**:266, 1917.

3. Howard, H. J.: Thelaziasis of the Eye and Its Adnexa in Man, Am. J. Ophth. **10**:807, 1927; two plates.

4. Hsü, H. F.: On Thelazia Callipaeda Railliet and Henry, 1910 Infection in Man and Dog, Arch. f. Schiffs- u. Tropen-Hyg. **37**:363, 1933; three figures in text.



Thelazia californiensis from man: *1.* Male, entire worm, showing the characteristic hooked appearance of the caudal end; reduced from × 22.

2. Male, caudal end, showing comparative lengths of the left and right spicules; reduced from × 110.

3. Female, anterior end, showing the position of the vulva caudad to the junction of the esophagus and intestine, and the coarse transverse cuticular striations; reduced from × 110.

4. Female, caudal extremity; reduced from × 176.

5. Male, caudal extremity, showing the arrangement of the caudal papillae; reduced from × 176.

Abbreviations: *an.*, anus, *buc. caps.*, buccal capsule; *lft. spic.*, left spicule; *int.*, intestine; *n. r.*, nerve ring; *oes.*, esophagus; *postan. pap.*, postanal papillae; *prean. pap.*, preanal papillae; *rt. spic.*, right spicule; *vulv.*, vulva.

REPORT OF AMERICAN CASE

In 1928, three nematode worms were removed from the eye of a practicing physician in Porterville, Calif., by Dr. Austin Miller, and sent to us for identification. Examination disclosed that they belonged to the genus Thelazia, but that they differed somewhat from T. callipaeda so far as existing inadequate descriptions made comparison possible at that time. Subsequent comparisons with specimens of T. callipaeda from man and dog in China and with T. californiensis from dogs in California revealed that these specimens from man in California were Thelazia californiensis. This constitutes the first report of the occurrence of T. californiensis as a parasite of man. It is also the first report of human thelaziasis in America.

The history of this American case, obtained by Dr. Miller, may be summarized as follows:

> Dr. G., a practicing physician, aged 42, complained of a slight irritation as of a foreign body in the right conjunctival sac. The conjunctiva appeared only slightly, if at all, reddened. Instillation of a drop of 2 per cent butyn solution caused the appearance of an exceedingly active squirming worm on the conjunctiva near the outer canthus. Three such worms were removed. With the removal of the worms all symptoms disappeared, and there has been no reappearance of worms or of irritation. The patient's residence was Nova Scotia from birth until the age of 5, New England from the age of 5 until the age of 36, California from the age of 36 to date. The only incident in the patient's previous history which Dr. Miller thought possibly gave a clue to the source of infection was that ten days prior to the first appearance of irritation a gnat or some other flying insect got into his right eye. This incident occurred while he was on a trip in the Sierra Nevada mountains.

MODE OF TRANSMISSION

The life histories of the thelazias are unknown. It seems probable, from what is known of the life histories of related nematodes, that intermediate arthropod hosts are involved. However, no evidence for this has been obtained, and it seems to us very unlikely that the insect mentioned in the history of the case in California had anything to do with the infection. Direct infection by transplantation of worms to the conjunctival sacs of cats, rabbits, dog and monkey was effected by Faust,[5] using T. callipaeda. In the conjunctival sacs of the rabbits and the dog the worms were still present a year after transplantation. This observation seems to indicate the possibility of an accidental direct transmission of the parasites from dog to man. However, this also seems very unlikely, in view of the fact that in one case six, and in another twenty-one, worms were taken from the human eye (cases of Stuckey and Hsü), numbers which could hardly have been accidentally transplanted from dog to man as mature worms.

---

5. Faust, E. C.: Studies on Thelazia Callipaeda Railliet and Henry, 1910, J. Parasitol. **15**:76, 1928; two plates and two figures in text.

DESCRIPTION OF SPECIMENS

Of the three specimens of T. californiensis recovered in the American case, one was a male, and two were females. The male worm measured 10.26 mm. in length and 0.25 mm. in diameter. The esophagus was 0.394 mm. long. The longer spicule (left) measured 1.83 mm. in length; the shorter spicule, 0.167 mm. The preanal papillae were asymmetrically placed; there were six on the left side and four on the right. The normal number of preanal papillae in this species is six or seven pairs. Such abnormalities as this are not rare among the nematodes. Only two pairs of postanal papillae could be seen, although the normal number in this species is three pairs. The transverse body striations numbered from 55 to 111 per millimeter.

The female specimens measured, respectively, 13.23 and 11.44 mm. in length and 0.294 and 0.325 mm. in diameter. The esophagus measured 0.450 mm. in length. The vulva was located about 0.25 mm. posterior to the junction of the esophagus and intestine in both specimens. The lengths of the postanal regions were 0.078 and 0.092 mm. The transverse body striations numbered from 42 to 77 per millimeter. Measurements of mature uterine ova are of little value for specific diagnosis, as the ova are very thin-shelled, hence variable in shape when crowded together. Under normal conditions the ova hatch within the uterus or, more accurately, metamorphose, the thin membranous shell forming a sheath around the larvae. In both female specimens the enlarged part of the uterus was packed with fully formed larvae.

The specimens from man were somewhat smaller in all measurements than specimens of the same species obtained from dogs in California. Hsü noted that specimens of T. callipaeda from man in China were somewhat smaller than specimens of that species from dogs in the same locality. These observations seem to indicate that man does not serve as the optimum host for either species.

DIFFERENTIATION OF SPECIES

The two species may be separated from one another on the basis of the relative fineness or coarseness of the transverse cuticular striations. In T. callipaeda these striations number from 150 to more than 300 per millimeter, while in T. californiensis they number from 30 to 111 per millimeter. This is a character which may be studied readily in living or in killed, uncleared specimens. If the specimens are suitably cleared, preferably in phenol, the two species may be separated on the basis of the number of caudal papillae in the male or the position of the vulva in the female. The male worms of T. californiensis have normally six or seven pairs of preanal papillae and three pairs of postanal papillae, as compared with the eight to ten pairs of preanal and five pairs of post-

anal papillae found in T. callipaeda. In T. californiensis the vulva is located posterior to the junction of the esophagus and intestine; in T. callipaeda the vulva is found anterior to that point.

THELAZIASIS IN DOGS

The importance of T. californiensis from the veterinary standpoint is coming to be recognized. At least nine cases of thelaziasis of dogs in California have come to light since the first reported case in 1929; it is probable that many more have been overlooked.

The cases of infection of dogs by Thelazia are rather widely dispersed in California. The dog is the only known host for T. californiensis except for this one case in man. Because of the association of the dog with man suspicion rests on the dog as the reservoir for human infection by Thelazia, both in China and in California. There was, however, in the human case in California no evidence of association with a Thelazia-infected dog or even of habitual contact with a dog prior to the appearance of the infection.

In both human and canine infections the worms can be readily detected by persistent exploration of the eyeball and conjunctival sac, though they are difficult to capture and remove because of the agility and rapidity of their movements and the ease with which they return to the deeper recesses of the conjunctival sac.

There is slight evidence of a seasonal prevalence of Thelazia in dogs in the early autum or of recurrence of the infection in the dog at this season and of its recurrence in the adult stage in the same dog from season to season.

The worms cause distress by their presence and by their movements on the sensitive membranes of the ocular surfaces. Dogs exhibit this distress noticeably when the worms are visible.

COMMENT

The portal of entry of Thelazia into the mammalian host is unknown, and a relationship to an arthropod host is not yet established, though suspected. It is obvious that owners of dogs should investigate and give veterinary care in all cases of ocular irritation with a view to the prevention of the spread of this worm infection to other dogs and to man. A physician detecting Thelazia infection in man should look for the contacts of his patient with dogs and cats with a view to finding a possible reservoir host for this aberrant human parasite.

We shall be glad to examine and report on any specimens of nematodes secured from the eyes of man or domestic animals.

THE RELATION OF GLAUCOMA TO BLOOD PRESSURE

PAUL WEINSTEIN, M.D.
BUDAPEST, HUNGARY

The aqueous and the vitreous body in the eyeball are under a certain pressure; this pressure, developed within the eyeball, is transmitted to the semielastic sclera, and is called the ocular tension. If one disregards the condition of the sclera one finds that the normal tension is the result of a thermodynamic balance. This balance is maintained by the blood pressure in the capillary arteries and by the osmotic pressure of the blood albumins. The blood pressure causes the filtration of the aqueous, while the albuminous content of the blood lessens this filtrating pressure. The higher, therefore, the hydrostatic capillary blood pressure and the lower the oncotic pressure (the suction of the blood colloids) the greater is the ocular tension. Under pathologic circumstances (glaucoma) this balance is influenced by the osmotic pressure of the aqueous albumin and by the swelling property of the vitreous body. Besides these factors, however, there is another main factor—the semipermeability of the capillary walls. These walls permit the passage of salts but not of albuminous matter. This explains the hardly measurable quantity of albumin in the normal aqueous fluid. There is, however, a considerable amount of albumin in the aqueous following a paracentesis because the paracentesis changes the local state of the vegetative nervous system and this in turn causes greater permeability of the capillary walls for albumins.

In order to determine the relation of glaucoma to blood pressure I first of all made readings with the Plesch tonoscillograph. The tonoscillograms indicate also the condition of the vessel walls. I tested 150 patients with glaucoma who were from 24 to 75 years of age, 100 healthy persons of the same age, and 50 patients with thrombosis of the central retinal vein. The average blood pressure of the patients with glaucoma was 160 systolic and 85 diastolic, and that of the healthier persons was 130 systolic and 76 diastolic. The higher blood pressure in the cases of glaucoma seems to be less marked if one takes the extreme cases into consideration. The systolic pressure ranges from 120 to 230 in patients with glaucoma against 120 to 200 in normal

---

Edited by Dr. Benjamin Friedman, New York.

From Eye Clinic No. 1 of the University of Budapest; Prof. Emil de Grosz, director.

persons, and the diastolic from 60 to 110 against 60 to 95. One cannot say, therefore, that hypertension predisposes to glaucoma. The rarity of glaucoma and the frequency of hypertension should also be borne in mind.

I next examined the precapillary pressure by the methods of Baillart and Seidel. The values obtained by each method in nonglaucomatous conditions run parallel, the average being 80 systolic and 30 diastolic. In cases of glaucoma, I obtained higher values when employing Baillart's instrument (this measures the pressure of the small arteries within the eye) on account of the increased ocular tension. This increase of blood pressure must be considered passive, because if the instrument of Seidel (measuring the blood pressure of the extrabulbar anterior ciliary arteries) is used, the higher pressure is not found.

Depending on the condition of the capillaries, paradoxical relationships between the blood pressure and the ocular tension may exist. Contraction of the capillaries elevates the blood pressure, but lessens the amount of blood reaching the eye and therefore lessens the tension. Pilocarpine, like amyl nitrite, dilates the small vessels and augments the amount of blood flowing into the eye, but by dilating the canal of Schlemm it quickens the outflow of fluids and reduces the tension. By means of a specially constructed apparatus (after Wegner) attached to a Recklinghausen sphygmometer I succeeded in demonstrating that the plethysmographic oscillations of the globe increase under the action of pilocarpine. This is indicative of increased blood flow (fig. 1) because, before the administration of pilocarpine, the oscillations were hardly perceptible.

In glaucoma, therefore, one does not find necessarily an increase of blood pressure in the larger and in the precapillary vessels. But on examining the function of the smallest arteries, which, as is well known, supply the cells with oxygen and bring about the thermodynamic balance previously mentioned, one finds a decided change. The resistance of the capillaries in the epidermis as measured by Herzog's method is normally equal to a pressure of from 40 to 50 mm. of mercury. In cases of glaucoma one finds the value of this resistance to be under 40, and this indicates a higher capillary blood pressure. It also indicates that patients with glaucoma belong to the vasoneurotic group. Vasoneurotic symptoms are frequently met with in the climacteric. It should be mentioned that in this clinic 60 per cent of the glaucomatous patients are females and 80 per cent of the acute attacks of glaucoma occur in females. The frequent signs of functional lability of the small vessels during the climacteric, such as hot flushes and perspiration, prove that vasolability is a rather characteristic observation and probably in the eye takes the form of glaucoma. My associates and I have found the

value of capillary resistance during the climacteric to be over 40 to 50 mm. of mercury in nonglaucomatous persons and under 40 to 50 in patients with glaucoma.

The tonoscillographic curves of the climacteric cases of hypertension indicate normal elasticity of the vessel walls (fig. 2). This elasticity explains why the smallest vessels can react by contracting and dilating instantly under different influences. Psychic, chemical and meteorological stimuli are all apt to elicit attacks of glaucoma. The statistics of this clinic prove that acute attacks are much more frequent in the winter than in the summer seasons. Though it is well known that climatic

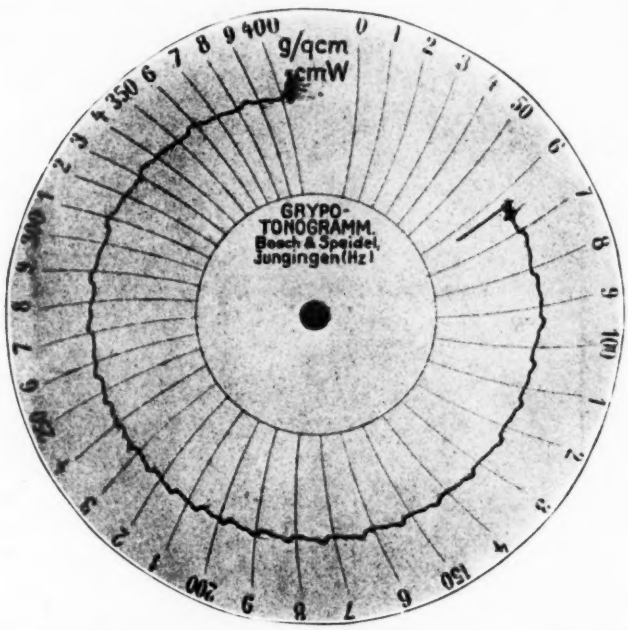


Fig. 1.—Increased blood flow in capillaries of the eye under the action of pilocarpine as shown by increased oscillations of the globe recorded by the plethysmograph.

factors influence the circulatory system, the mechanism (histamine [?], Friedenwald) is not yet known.

When the capillaries of the eye dilate, although the pressure within them lessens, the blood flow is increased fourfold, according to the formula of Poiseuille; therefore the volume of the eye grows and its tension becomes higher.

In contradistinction to the higher capillary pressure in cases of primary glaucoma one finds a higher pressure in the precapillaries of the eye in the cases of glaucoma secondary to thrombosis of the central retinal vein. One finds also that in 90 per cent of these cases the tonoscillographic curve is of the arteriosclerotic type (fig. 3). In the

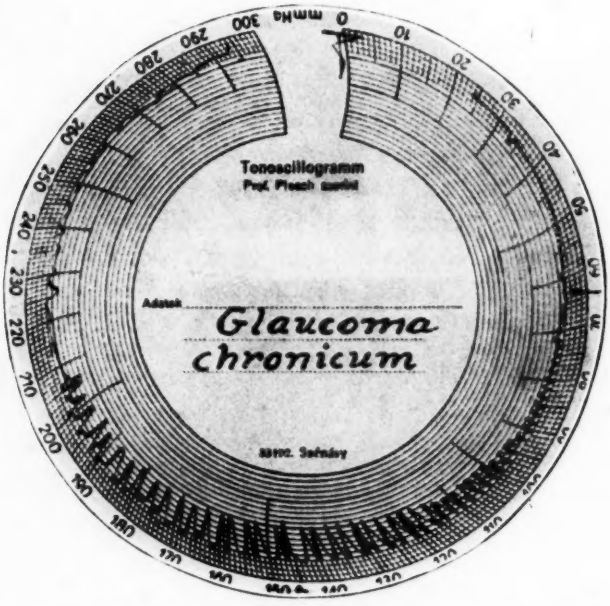


Fig. 2.—A tonoscillographic curve in a climacteric case of chronic glaucoma with hypertension, indicating normal elasticity of the vessel walls.

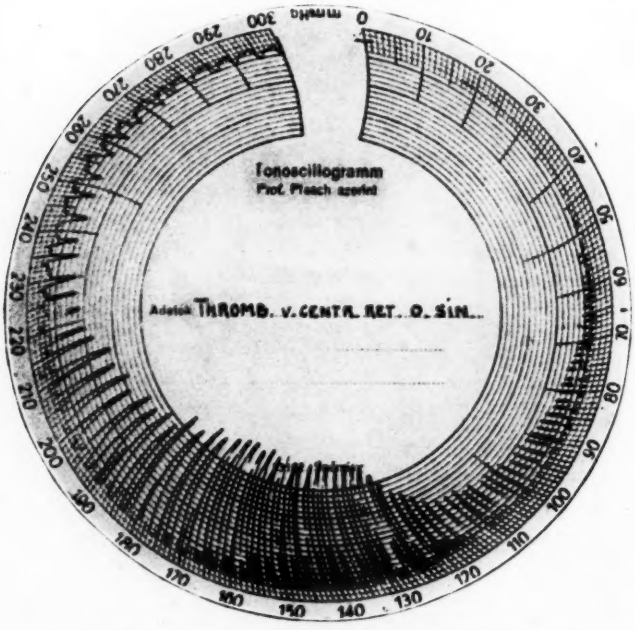


Fig. 3.—A tonoscillographic curve of arteriosclerotic type in a case of glaucoma secondary to thrombosis of the central retinal vein.

patients with this condition the increased pressure in the smaller arteries causes hemorrhages and thrombosis, and as a secondary consequence glaucoma develops, possibly through disturbance of the nutrition and of the local cell function.

The characteristic features of hemorrhagic glaucoma and of acute and chronic glaucoma may be outlined as follows:

Hemorrhagic Glaucoma	*Acute and Chronic Glaucoma*
A tonoscillogram showing stiff-walled, high excursions	A normal tonoscillogram
Arteriosclerotic hypertension	Climacteric
Hemorrhages in the fundus along the precapillary vessels	Essential hypertension
A rather deep anterior chamber	Possible postoperative hemorrhage along the capillaries
	A shallow anterior chamber

Glaucoma simplex is a special type. Although the tension of the eye here is a little higher than normal the head of the optic nerve degenerates, frequently in spite of operative intervention. According to the statistics of this clinic, glaucoma simplex is more frequent in males. The tonoscillograms of glaucoma simplex are between the climacteric type (normal elasticity) and the arteriosclerotic (stiff-walled) type. They resemble the arteriosclerotic more than the former type. Arteriosclerosis is more common in males. It may be that in the eye certain changes occur in connection with the arteriosclerotic process which causes degeneration of the optic disk. The following points seem worthy of consideration: Because the precapillary vessels are narrower in arteriosclerosis the capillaries receive a smaller amount of blood, and therefore malnutrition of the tissues ensues. Those who use nicotine to excess and who suffer from optic neuritis are found to have tonoscillograms of the arteriosclerotic type; therefore it is probable that arteriosclerosis renders the optic nerve susceptible to toxic influences. My experiments with the Warburg apparatus showed that normal aqueous could augment to a higher degree the oxidative energy of the cell than Ringer's solution. It seems possible that in arteriosclerosis the aqueous lacks the substance (vitamin C ?) necessary to stimulate the production of oxidative energy in the cells because the filtration of this substance through the sclerotic walls is impaired.

SUMMARY

Acute and chronic glaucoma are characterized by vasolability, by higher pressure in the smallest vessels (capillaries) and by their close association with disturbances of the internal secretions occurring in the climacteric (Imré) and in the menstrual disorders of young women. Marked stiffness of the greater vessels and narrowing of the precapillaries are found in cases of hemorrhagic glaucoma. A nutritional

disturbance caused by a prearteriosclerotic condition might explain the development of glaucoma simplex.

Further studies are necessary to show the connection between general disease, such as diabetes, nephritis or syphilis, and the changes found in the arteries in the different types of glaucoma. Other factors which must be known are the albuminous content of the aqueous, the condition of the vitreous body and the abnormalities of the filtration angle and of the canal of Schlemm in order to understand clearly why the anterior chamber is shallow in many cases and of normal depth in others. There is no question that besides the changes in the arterial system there are local factors in the eye that predispose to glaucoma.

CHEMISTRY OF THE LENS

VI. LIPIDS

ARLINGTON C. KRAUSE, M.D.
BALTIMORE

The relation of lenticular lipids to cataract has been a point of interest to ophthalmologists for many years. However, in spite of numerous investigations the lenticular lipids have not been well characterized. For this reason much confusion has arisen in ophthalmologic literature in the discussion of lipids in cataracts.

Lipids in myelin forms are frequently seen in cataracts. The lipids which may give rise to these forms are: (1) the phospholipids, that is, lecithin, cephalin and sphingomyelin, and (2) the cerebrosides, namely, kerasin, phrenosin, nervone and hydroxynervone. Myelin is a term often applied to birefractive substances as well as to substances with a myelin form. In addition to unmasked phospholipids and cerebrosides many organic and inorganic substances, such as calcium salts and cholesterol esters, may also be birefractive. It is unfortunate that the term myelin is so poorly defined that it causes confusion in the ophthalmologic literature.

Myelin forms in cataracts arise from the unmasking of the phospholipids and cerebrosides present in the normal lens, and these forms are modified by the cholesterol usually associated with them. Mettenheimer [1] first observed myelin in cataracts in 1858. Metzger [2] found myelin in coronary cataract. Hoffmann [3] noted that it was present in lamellar, traumatic, senile and complicated cataracts and in the lens of the calf after autolysis but not in the normal human lens. He believed that myelin forms occur after degeneration of the lens. Kranz [4] noted that myelin was not birefractive in the lens after autolysis. He showed that birefractive myelin and cholesterol occurred in traumatic cataracts produced by injury from a blunt object but not in lamellar cataracts or in

From the Wilmer Ophthalmological Institute of the Johns Hopkins University and Hospital.

1. Mettenheimer: Cor.-Bl. d. Ver. f. gemeinsch. Arb. z. Förd. d. wissensch. Heilk., 1857, no. 24; 1858, no. 31. Quoted by Kranz.[4]

2. Metzger: Lipoidbefunde bei Cataracta coronaria, Klin. Monatsbl. f. Augenh. **87**:850, 1931.

3. Hoffmann, M.: Der kataraktöse Zerfallsprozess der Linse und seine Darstellung in Reagenzglase, München. med. Wchnschr. **61**:584, 1914.

4. Kranz, H. W.: Die polarisationsmikroskopische Untersuchung der kataraktös getrübten Linse, Arch. f. Ophth. **118**:571, 1927.

traumatic cataracts produced by perforating injury. He found only birefractive lipids in black and senile cataracts but no myelin forms. Wessely [5] reported that he detected birefractive calcium soaps, phosphates and carbonates mixed with cholesterol in the lens. It is probable that all these substances are products of the decomposition of the lipids. At present it is impossible to determine accurately by chemical means the exact nature of these myelin-forming and birefractive substances in one small lens. Histochemical qualitative tests are unsatisfactory because they generally suggest but often do not prove that a specific substance is present. The nearest approach to this problem is the analysis of a large number of lenses in order to determine the kind of lenticular lipids which may give rise to myelin.

Lipids of the Bovine Lens (1 Year Old)

Lipid	Lens	
	Moist, Gm. per 1,000 Grams	Dry, Gm. per 1,000 Grams
Total lipids	3.237	9.646
Fats, (glycerides of fatty acids)	0.041	0.122
Total phospholipids	1.930	5.751
Lecithins	1.242	3.701
Cephalins	0.310	0.924
Sphingomyelins	0.378	1.126
Cerebrosides	0.042	0.125
Cholesterol	0.660	1.967
Carotenoids		
"Carotene"	0.0023	0.007
"Xanthophyll"	0.0000	0.000
Undetermined unsaponifiable substances	0.538	1.603
Free fatty acids	0.010	0.029
Lipids recovered after alkaline hydrolysis of tissue	0.014	0.042

It is not necessary to give a historical survey of the literature on the analysis of lenticular lipids, as this has been done many times recently by other writers. O'Brien and Salit [6] have given an excellent report of the literature on the lipids of the lens. Most of the published analyses are concerned with the variation in the amount of cholesterol in the cataractous lens and in the normal lens with respect to age. The significant discovery is that cholesterol increases with the age of the lens and with the maturity of the cataract. The results of the estimations which have been reported for the lenticular lecithin are questionable because they represent the quantity of phosphorus-containing lipids and include sphingomyelin and cephalin as well as lecithin. Also the fatty acids resulting from the hydrolysis of the phospholipids, cerebrosides and true fats have frequently been recorded as fats in the lens. Furthermore, some writers have disregarded the fact that many substances which

5. Wessely, K.: Zwei kleine Beiträge zur Pathologie der Linse, Arch. f. Augenh. **91**:158, 1922.

6. O'Brien, C. S., and Salit, P. W.: Chemistry of the Lens, Am. J. Ophth. **16**:863, 1933.

are extracted from the lens by alcohol and ether are not lipids; thus many of the published results give a false impression.

The purpose of this communication is to show the nature and the distribution of the lenticular lipids. The experimental procedure used in this connection was described in a previous article on the lipids of the sclera, cornea, choroid and iris.[7] The distribution of the lenticular lipids is given in the table. The iodine number for the lenticular cephalin was 61.2, for lecithin, 52, and for the fatty acids of the glycerides, 67.4.

COMMENT

The amount of total lipids in the lens is very low and corresponds to the quantity in the corneal substantia propria. In the other ocular tissues it is much higher. The amount of fats in the lens is the lowest of all such amounts in ocular tissues. The fats are glycerides of stearic, palmitic, oleic and probably also of linolic, linolenic and arachidonic acids, the first four acids predominating. The free fatty acids are probably, in part, lactic acid and the lower aliphatic acids, such as acetic, butyric and caproic acids, and, in part, fatty acids resulting from decomposition of the lipids.

The amount of phospholipid is partly dependent on the number of active living lenticular cells. It is true that lecithin and cephalin are vitally necessary lipids and are found chiefly in the epithelial cells of the lens. There are probably many lecithins and cephalins, depending on the kind of higher fatty acid group attached to the molecule. The data show that the phosphorus-containing lipids are only about two-thirds lecithin and about one-third cephalin and sphingomyelin. The cerebrosides, depending on the derivative of lignoceric acid associated with them, are probably phrenosin, kerasin and possibly nervone and hydroxynervone.

In the normal lens, the cholesterol was found free and not as an ester. In the pathologic lens it may be either free or combined or both. The other unsaponifiable substances are chemically unknown. They may be aliphatic alcohols and cholesterol derivatives. There is an indication that cetyl alcohol is present in the lens.

The quantity of "carotene" found was minimal because some of this substance was undoubtedly destroyed by the action of light and by oxidation during manipulation. "Carotene" is to be considered as a hydrocarbon carotenoid. Perhaps in the lens it is chiefly a true carotene. In contrast to the sclera, no xanthophyll was found.

The discussion of the chemical significance of the lenticular lipids is limited because there is a lack of knowledge concerning the function

---

7. Krause, A. C.: The Lipids of the Sclera, Cornea, Choroid and Iris, Am. J. Physiol. **110**:182, 1934.

of the lipids. There is no doubt of the possibility that lipids are sources of energy and that they are necessary for the life of the lenticular cells. The essential lipids are the phospholipids, which probably are in association with cholesterol. In many ways, the phospholipids behave like proteins in their reaction toward acids, bases and salts. They are amphoteric and are physically unstable at their iso-electric point. The association of phospholipids with calcium, magnesium and potassium suggests some physiologic function of these compounds which still awaits discovery.

SUMMARY

The distribution of fats, lecithin, cephalin, sphingomyelin, cerebrosides, cholesterol and carotenoids in the lens has been determined.

DETACHMENT OF THE RETINA

OPERATIVE RESULTS IN ONE HUNDRED AND FIFTY CASES

JOHN H. DUNNINGTON, M.D.
AND
JOHN P. MACNIE, M.D.
NEW YORK

This paper presents an analysis of the operative results in 150 cases of retinal detachment seen in the ophthalmologic department of the Presbyterian Hospital between October 1930 and April 1, 1934. One hundred and ninety-seven operations were performed on 155 eyes; both eyes were operated on in 5 cases. Since no attempt was made to select the cases, many so-called hopeless ones were included in this group. All patients for whom the possibility of spontaneous cure had been eliminated were offered a chance by surgical intervention. This attitude was assumed with the hope that we might learn by experience more about the indications for operating for this condition. With the same idea in mind, we have analyzed the failures as well as the successes. The operative technics employed were the Gonin cautery puncture, chemical cauterization as described by Guist and Lindner and the electrocoagulation method of Walker. A comparison of the results obtained by each method is given.

GENERAL STATISTICS

Sex.—It is interesting to note that of this series of 150 patients 64 per cent were males and 36 per cent were females. These percentages are very close to those given by Shapland [1] for his series of 425 patients, his figures being 61.2 per cent males and 38.8 per cent females.

Age.—The average age was 39.8 years, the youngest patient being 5 years of age and the oldest 75. The interesting feature in the statistics on age is that in each decade between 20 and 60 there was no material difference in the number of cases encountered, nor did we find that age had any bearing on the result of the operation.

Trauma.—Forty-five of the 150 patients gave a definite history of trauma, and 17 gave a history suggestive of injury, so we can say that trauma was a definite factor in producing the detachment in 30 per cent of the patients and was at least a probable factor in 41.3 per cent.

From the Institute of Ophthalmology, Presbyterian Hospital.

Read before the American Academy of Ophthalmology and Otolaryngology, Chicago, Sept. 11, 1934.

1. Shapland, C. D.: Retinal Detachment and Its Treatment by Surgical Methods, Brit. J. Ophth. **18**:1 (Jan.) 1934.

Studying the frequency of trauma in relation to the refractive error showed that definite trauma was responsible for 41.6 per cent of the detachments in persons with hyperopia, while of those with high myopia only 27.4 per cent gave a positive history of injury. Of the 62 persons with a traumatic history, 45.1 per cent were either cured (30.6 per cent) or improved.

OCULAR FINDINGS

No particular preference was found as to the eye involved. In this series of 150 cases the right eye alone was afflicted in 64 instances and the left eye alone in 62, and both eyes were involved in 24 instances. In 5 of the bilateral cases aphakia was present.

Refraction.—A study of the refraction was undertaken to determine, if possible, the rôle that myopia plays in the production of detachment. No definite information was obtained other than that myopia exists in 66.6 per cent of the cases, while either emmetropia or hyperopia was

TABLE 1.—*Relation of Myopia to Detachment*

Refraction	No. of Cases	Percentage
+ to 0	38	25.31
0 to —3.00	20	13.33
—3.00 to —6.00	18	12.0
—6.00 up	55	36.6
Aphakia with:		
(a) Hyperopia	5	3.33
(b) Moderate myopia	2	1.33
(c) High myopia	5	3.33
Unknown	7	4.65

present in only 28.6 per cent. The detachment followed extraction of a cataract in 12 cases (8 per cent), but of these 5 were known to be cases of high myopia and 2 of moderate myopia (refraction from —3 to —6) before cataract extraction. In 7 instances (4.6 per cent) sufficient data were not obtainable to ascertain the refractive state. The frequency of retinal detachment in myopia is well known, but it is interesting to note that Shapland found myopia in 62.3 per cent, while, if we exclude the cases of aphakia as he did, our percentage is 61.9 per cent.

Muscular Imbalance.—It was our endeavor to determine what, if any, muscular imbalance was produced by the severance and reattachment of the rectus muscles. From our data it seems that postoperative diplopia is rare, as in only 2 cases was any note made of its presence; however, in 20 instances postoperative tests showed a slight paresis of the detached muscle. In 1 case an overaction of the reattached muscle was obtained, requiring a prismatic correction for the resultant hyperphoria.

Intra-Ocular Tension.—In 55 of these cases in which a careful preoperative and postoperative record of the intra-ocular tension (with the Schiötz tonometer) was available, the average tension before opera-

tion was 11.1 mm. of mercury, while in the same cases the postoperative tension was 10.1 mm. The average postoperative tension in 50 of the cases in which cure or improvement occurred was 11.6 mm., while in 55 cases of failure the average postoperative tension was 9.5 mm. In 10 of these cases there was postoperative hypotony with a pressure of 6 mm. or lower, the average being 2.5 mm. If these cases are excluded from the failures the average tension in the others is 11 mm. This indicates that the operation itself has no appreciable permanent effect on the intraocular tension. In 5 of the 55 cases a preoperative tension of less than 6 mm. was noted, and in none of them was a cure effected, although in 2 instances the postoperative tension rose to 10 mm. or more. This is in accord with the general impression that profound hypotony is a grave prognostic sign.

Changes in the Crystalline Lens.—Lenticular opacities developed postoperatively in 7 instances, yet in none of them was a satisfactory result obtained. In no case of a successful operation was there any clouding of the lens as a postoperative complication. The time since operation is, of course, too short to predict the future developments in these cases, but it is interesting to note that lenticular opacities have developed in so small a number of even the cases in which failure resulted. The cases in which postoperative cataracts developed were all cases of extensive detachment, usually with profound hypotony.

Changes in the Field of Vision.—In the vast majority of these cases the defect in the field of vision corresponded rather closely to the area of detachment. When a successful reattachment was effected, the field for form usually returned to normal or near normal, although residual defects were frequently encountered. Refined perimetry is essential to elicit these defects, but it is our opinion that if the tests are carefully done some impairment of function is demonstrable in almost all of them. The amount of impairment depends not only on the preoperative viability of the detached retina but on the extent of the damage resulting from the operative procedure. A study of the changes in the fundus in the successful cases convinces us that the degree of reaction necessary for a cure must impair somewhat the function of the treated retina.

Relation of Time of Onset to Operative Results.—A detailed analysis was made of this phase to determine, if possible, what effect a reasonable delay would have on the result. To our surprise we found that the results were just as good in the cases of over three months' duration as they were in those of less than one month's duration. The figures in table 2 show this rather strikingly.

Cases of long standing were too few to justify any conclusion, but suffice it to say that in 1 instance a reattachment with a return of the field was effected in a case of detachment of at least five years' duration. A study of these figures reveals that if a detachment is not progressing a reasonable delay does not materially lessen the chances of success.

With this thought in mind we next tried to determine whether the detachments invariably progressed. Many of the cases were not observed for any great length of time prior to operation, while in others the data were inconclusive. However, one gathers the impression from a study of these records that in frank cases progression is the exception rather than the rule.

Relation of Extent of Detachment to Operative Results.—Approximately one half of the retina was detached in 97 of the 150 cases, and a cure was effected in 49.5 per cent. Approximately three fourths of the retina was detached in 36 of the cases, and a cure was obtained in only 25 per cent. There was almost complete detachment in 21 cases, cure being obtained in only 9.5 per cent. In 1 case in which only one

TABLE 2.—*Relation of Time of Onset to Operative Results*

	Time of Operation		
	Within 1 Mo.	1 to 3 Mos.	3 Mos. or More
One half of retina detached			
Cure	23 (50%)	30 (48.3%)	16 (55.5%)
Improvement	3 (6.5%)	3 (4.8%)	3 (10.3%)
Failure	29 (43.6%)	29 (46.8%)	10 (34.2%)
Three fourths of retina detached			
Cure	5 (22.7%)	7 (23.3%)	4 (13.0%)
Improvement	3 (13.6%)	3 (10.0%)	1 (4.3%)
Failure	14 (63.6%)	20 (66.6%)	19 (82.4%)

TABLE 3.—*Relation of Site of Detachment to Results*

Location	No. of Cases	Cure	Improvement	Failure
Superior	22	10 (45.4%)	1 (4.6%)	11 (50%)
Inferior	48	23 (47.9%)	4 (8.4%)	21 (43.7%)
Temporal	21	12 (57.1%)	1 (4.8%)	8 (38.1%)
Nasal	6	3 (50%)	1 (16.6%)	2 (33.3%)

fourth of the retina was detached a successful result was obtained. From a comparison of these results it seems that the extent of the detachment is an important prognostic sign. One may argue, of course, that in the cases of extensive detachment, disease of the retina, choroid and vitreous is more common. In spite of the truth of this statement, the mere extent of the detachment seems to have an important bearing on the outcome. Another important factor in reducing the chances of success in cases of widespread detachment is the necessary extensiveness of the operative procedure. This leads one to wonder whether in such cases the results would not be better with two smaller operations than with an extensive one, which was tried in a few instances. This is merely a thought which we hope time will answer. A review of the cases in which more than one operation was required shows that in over one fourth of them the detachment involved at least three fourths of the retina. Another interesting thing is that while the outlook is poor in

cases in which there is almost complete detachment, cure was obtained in 9.5 per cent. This should spur one on to further attempts at restoration of vision in these so-called hopeless cases.

Relation of Site of Detachment to Operative Results.—In the 97 cases with one half of the retina detached we found the inferior half to be involved twice as often as any other part. The location of the detachment seems to have no appreciable bearing on the outcome.

Relation of Type of Detachment to Operative Results.—A study of the type of detachment in the 97 cases with involvement of one half of the retina was undertaken to see whether a bullous or a flat detachment responded better to surgical intervention. The figures are shown in table 4. It can be seen by a study of these figures that most of the detachments were described as bullous, but that the percentage of cures and improvements is essentially the same for the two groups.

TABLE 4.—*Relation of Type of Detachment to Result*

Type	No. of Cases	Cure	Improvement	Failure
Bullous	81	40 (49.4%)	6 (7.4%)	35 (43.2%)
Flat	13	7 (53.8%)	1 (7.7%)	5 (38.5%)
Mixed	3	1 (33.3%)		2 (66.6%)

TABLE 5.—*Relation of Holes to Result*

Result	Irregular Tear	Round or Oval	Tongue	Disinsertion	Multiple
Cure	3 (20%)	21 (52.5%)	5 (46.5%)	10 (45.4%)	8 (42.1%)
Improvement	.....	3 (7.5%)	.....	1 (4.5%)	2 (10.5%)
Failure	12 (80%)	16 (40.0%)	6 (54.5%)	11 (50.0%)	9 (47.4%)

Relation of Holes to Operative Results.—In 86 (56 per cent) of the 155 eyes one or more holes were found, while in 69 (44 per cent) none were seen preoperatively. Furthermore, an attempt was made to determine whether the type of hole present could be of any prognostic value; so not only their presence but the nature of the holes was noted in relation to the result (table 5).

We were able to bring about benefit in 46.4 per cent of the 86 cases, cure in 41.8 per cent and improvement in 4.6 per cent, while in the 69 cases in which no holes were located the percentage of cures and improvements was 43.8 per cent (cure 34.7 per cent and improvement 9.1 per cent). In other words, the "blind" operations were almost as successful as those in which holes were located and treatment was concentrated around them. We do not wish to minimize the importance of sealing any existing holes but rather to emphasize the curability of lesions in which no holes are found, and the necessity for widespread treatment in all cases. We were least successful in those cases

in which there were irregular holes. One hesitates to draw any conclusion from so small a number. It is possible, however, that the difficulty in closing these irregular rents is responsible for the large percentage of failures in this group.

DESCRIPTION OF OPERATIONS

Cautery Puncture (Gonin).—The retinal hole was carefully localized. At operation the sclera in the region of the hole was exposed, and a short linear incision was made through it to the choroid. The cautery tip was heated to a dull red and was inserted through the hole in the sclera and allowed to remain in the vitreous body five seconds. The conjunctival wound was closed with interrupted sutures and atropine (3 per cent) was instilled.

Multiple Scleral Trephinings with Chemical Cauterization of the Choroid (Guist and Lindner).—The sclera in the region of the detachment was exposed, one or two of the rectus muscles being cut if necessary. With a 1.5 mm. trephine, openings were made in this area, the disks being dissected out to denude the choroid. The whole area of the detachment was treated in this manner, as many as twenty or more openings being made. The choroid was touched with a crystal of potassium hydroxide for five seconds and immediately neutralized with 0.5 per cent acetic acid, following which the whole field was irrigated with physiologic solution of sodium chloride. Several openings were made in the choroid in dependent positions with a punctum dilator. Usually a copious flow of subretinal fluid was obtained. The muscles were reattached to their stumps, the conjunctiva was sutured and atropine was instilled.

Diathermy (Walker Instrument).—The sclera over the detachment was exposed as in the Guist operation. Platinum needles were inserted over the detached area, the current being so adjusted that perforation took place with little pressure. A current up to 100 milliamperes and even higher was necessary at times. The needles were withdrawn, following which subretinal fluid escaped. The wound was closed and atropine was instilled.

Combined Operation.—Some surgeons have combined the scleral trephine and diathermy operations. This was done for the purpose of obtaining better evacuation of the subretinal fluid.

With only a few exceptions the operation for detachment was done with general anesthesia, avertin with supplementary ether being used. In our experience there seemed to be as much postoperative nausea and vomiting following local anesthesia as following general anesthesia. It was suggested that traction on the globe during the operation was responsible for this in either case, and as the operative procedures were more easily performed with the patient unconscious, a general anesthetic was usually chosen. As soon as consciousness returned the patient was placed on his back and kept in this position with as little as possible motion of the head for two and one-half weeks. If the detachment had occupied the inferior portion of the globe, the patient's head was slightly elevated but was kept constantly in this position. It was felt that this period of quiet was important.

Both eyes were bandaged at the conclusion of the operation, and the dressing was changed for the first time on from the third to the fifth day postoperatively; it was then changed on every other day, until both dressings were omitted on about the seventeenth day. A 1 per cent solution of atropine sulphate was instilled at each dressing into the eye on which operation had been performed, and no attempt was made to observe the fundus until usually the ninth day after the operation.

When both dressings were removed on about the seventeenth day, the patient was allowed to get up by easy stages, and both eyes were uncovered for a longer interval each day. The patient was usually ready for discharge about twenty-one days after the operation. The sutures were removed from the conjunctiva and muscles on the day before discharge from the hospital.

After leaving the hospital the patient was urged to lead a quiet life for a few weeks and to avoid any strain, such as that associated with lifting or jars.

RESULTS

Of the 155 eyes operated on, the condition was either cured or improved in 47.8 per cent (cured in 38 per cent and improved in 9.8 per cent) while failure resulted in 52.2 per cent. Among these patients were 12 with aphakia, of whom only 3 were cured. A patient was considered cured when the retina was completely reattached and enlargement of the field was secured. The improved patients were those in whom the field of vision became enlarged yet some peripheral detachment persisted or in whom the retina was in place but the field of vision was not materially enlarged. One hundred and ninety-seven operations were performed on 155 eyes in 150 patients. Thirty-four patients had more than one operation; 1 had six operations, 2 had four, 7 had three and 24 had two. In no instance was a patient benefited after two previous operations had failed. Of the 24 patients who had two operations, 5 were improved and 6 cured. In each successful instance the first operation was followed by at least a temporary improvement.

Practically all of the patients who were cured or improved showed preoperatively opacities of the vitreous varying from a few fine to dense strands of opacities. Twenty-two patients showed pigmentary changes in the periphery with cystic degeneration of the retina. Three presented the picture of an old exudative choroiditis, and in 5 hemorrhages into the retina were found. In 1 instance a rupture of the choroid was associated with the detachment.

Visual Acuity in Cases in Which Cure Was Obtained.—The visual acuity before and after operation was studied in 56 cases in which cure was obtained. In 5 the acuity was worse after operation; however, in 4 of these the patient was able to read the line on the test chart that was next in size to the last line that he could read before operation. In 1 case vision was reduced from 20/30 to 20/100. In 29 cases final vision was 20/50 or better, while in 20 cases it was 20/40 or better, being improved to this from as little as 3/200. In 47 cases the vision was 20/200 or better after the operation.

Poor central vision usually could be attributed to preoperative retinal disease, myopic changes frequently being the cause. In 1 case a typical hole in the macula was found. It is our impression that once

the macula has become detached restoration of central vision does not follow reattachment of the retina.

Comparison of Results Obtained by Different Operative Measures.—The actual cautery operation as described by Gonin was done in 6 cases, with failure in all. In each of these cases an attempt was made to localize and seal the hole. It is possible that improper technic was responsible for the failures, but great care was exercised in the selection and study of these cases as well as in the performance of the operation.

In comparing the results obtained by the different technics, it was thought fairer to include only those cases in which one operation was required, as often if one technic failed another was tried, making it difficult to determine to which method to attribute the result. The cases in which only one operation was performed numbered 120, the Guist-Lindner method being used in 92, the Walker diathermy method in 18 and the combined method in 10. Chemical cauterization resulted in cure in 46.7 per cent of the cases, in improvement in 6.5 per cent and in failure in 46.7 per cent, while the electrocoagulation method resulted in cure in 38.8 per cent, in improvement in 16.6 per cent and in failure in 44.5 per cent. The total percentages of patients benefited by these two procedures were essentially the same, although the proportion of cures was greater in the group for whom the Guist-Lindner technic was used. The larger percentage of improvement obtained by the diathermy method may possibly be due to too conservative treatment; a little more radical treatment might have resulted in a complete reattachment.

ANALYSIS OF FAILURES

In the 81 cases in which the operation was not a success an attempt was made to determine the causes of failure. In 20 cases no reason could be determined.

Of the conditions existing before operation which may have contributed to failure the commoner were the magnitude of the detachment in 42 cases and the presence of high myopia in 26. Atrophic changes in the retina and choroid were noted in 12 cases and hemorrhages in the vitreous and retina were observed in 9. Inflammatory changes were seen in the retina and choroid in 2 cases, old uveitis in 1 case and retinitis proliferans in 1 case. Marked arteriosclerosis and vascular hypertension were present in 2 cases. There were 3 cases of intra-ocular foreign body; in 2 instances the body had been removed before the diagnosis of detached retina, and in the other an attempt at removal had been unsuccessful. In 3 cases a preceding Gonin operation had led to scar formation in the retina and the development of traction bands in the vitreous. In this group there was also 1 case of

each of the following conditions: glaucoma in which a corneoscleral trephine operation had been performed six months previously, a large coloboma of the choroid, metastatic carcinoma (?), epilepsy, microcornea with high myopia and high myopia with a dislocated lens.

In 8 cases in which the Guist operation was being performed premature perforation of the globe occurred, resulting in loss of vitreous and an unsatisfactory result. Overtreatment leading to prolonged inflammation of the eye or definite injury was present in 4 cases.

Postoperative vitreous hemorrhage was considered to result in failure in 9 cases and uveitis in 7. In 7 cases the retina was in position on the patient's discharge from the hospital but became redetached subsequently. The longest interval at which this occurred was three months. In 7 other cases the area of detachment increased after the operation, and in 5 the presence of profound hypotony was thought to be responsible for the poor result. In 1 case each retinal hemorrhage, poor postoperative cooperation of the patient and the development of retinitis proliferans contributed to failure.

There were 9 aphakic eyes which were operated on without improvement. Routine cataract extractions had been performed on 6 from two to fifteen months before the operation for detachment. In 1 instance the diagnosis of detachment was made four and one-half years before; the lens was extracted, and then the detachment was operated on without improvement. In 1 a loss of vitreous at the time of extraction was noted. Linear extraction had been performed in 1 case eight years before and discission in 2 cases three and nineteen years preceding the operation for detachment.

Enucleation was finally performed in 3 cases of failure and evisceration in another case, giving a percentage of 2.5 in the whole series in which the eye was lost.

SUMMARY

In this series of 150 cases of retinal detachment 64 per cent of the patients were males and 36 per cent females. The average was 39.8 years, the oldest patient being 75 and the youngest 5 years of age.

A positive history of trauma was obtained in 30 per cent of these cases, with a history suggestive of injury in an additional 11.3 per cent, making a total of 41.3 per cent in which trauma was at least a probable factor. Some degree of myopia was present in 66.6 per cent, 36.6 per cent of the patients having 6 or more diopters of myopia; aphakia was present in only 8 per cent of the entire group.

The severance and reattachment of the rectus muscles rarely produced any noteworthy muscular imbalance.

The intra-ocular tension was not permanently affected by the operation. Marked hypotony was found to be a grave prognostic sign.

Postoperative changes in the crystalline lens were rarely noted.

Some impairment of the field of vision was commonly seen after a successful operation.

Detachment of approximately one half of the retina was cured in 49.5 per cent of the cases, while benefit was obtained in only 25 per cent of those with approximately three fourths of the retina detached.

The inferior half of the retina was detached about twice as frequently as any other part.

Those eyes in which no holes were found responded to operation about as well as those in which one or more holes were located.

In the 155 eyes operated on, the results were: cure in 38 per cent, improvement in 9.8 per cent and failure in 52.2 per cent.

The results obtained with the chemical cauterization method of Guist and Lindner were just as good as those obtained by the electrocoagulation method of Walker. Widespread treatment of the affected area seems to be necessary to affect a cure.

NOTE.—Some of the cases included in this series have already been reported by Dr. H. S. McKeown (Detachment of the Retina: The Guist Operation and Report of Cases, Arch. Ophth. **9**:64 [Jan.] 1933; Detachment of the Retina: The Guist Operation, Tr. Am. Acad. Ophth., 1932, p. 240), who allowed us to reanalyze them for this report.

NEURORETINITIS ASSOCIATED WITH SYMPTOMS OF ERGOT POISONING

REPORT OF A CASE

DANIEL KRAVITZ, M.D.
BROOKLYN

It has long been known that the eyes may be affected in cases of ergot poisoning, but instances of this complication are rare in this country, as I was unable to find a single case recorded in the literature. The report of a case of neuroretinitis following the ingestion of a small amount of ergot is deemed of sufficient interest to warrant the writing of this paper.

Meier,[1] an ophthalmologist, was the first person to record ocular complications in ergot poisoning. In 1852, there was an epidemic in the district in which he practiced in which 283 people were affected. He reported that amblyopia was a frequent sequel, but he failed to describe the fundi in these cases. In 23 cases, cataract, usually bilateral, developed, taking from six weeks to three months to mature; unless amblyopia was also present, operative removal gave good results. Von Bechterew,[2] a neurologist, noted that amblyopia developed in 25 per cent of a group of 89 cases. Cataract developed in 8 cases and nystagmus in 7.

Kortneff,[3] between 1889 and 1890, observed over 2,000 cases of ergot poisoning. In hundreds of cases there developed ocular symptoms, the most important of which were amblyopia and cataract. There was a lack of uniformity in the pictures presented by the fundi in the cases of amblyopia. In some, the retinas were slightly discolored and edematous, and the borders of the disks as well as the course of the vessels were indistinct. In other cases there was acute hyperemia of the disks and retinas, and the fundi appeared grayish red. In these cases, the borders of the disks as well as the vessels were clearly outlined. In other cases there were marked pallor of the retinas and disks and marked contraction of the vascular trunks.

According to Kolosoff,[4] individual susceptibility to ergot poisoning

1. Meier, L.: Arch. f. Ophth. **8**:120, 1862.

2. von Bechterew, W.: Ueber neuro-psychische Störungen bei chronischem Ergotismus; nach den Beobachtungen von Dr. N. Reformatzki, Neurol. Centralbl. **11**:769, 1892.

3. Kortneff, A.: Vestnik oftal. **9**:14, 1892.

4. Kolosoff, G. A.: Ergotism: Its Etiology, Clinical Signs, Course and Treatment; Principally According to Data of Epidemics of 1909-1910, Russk. Vrach **11**:55, 120 and 198, 1912.

varies extremely. He reported cases of poisoning due to the ingestion of insignificant amounts of ergot, while in other cases, the ingestion of large amounts did not produce any symptoms. Kolosoff proved this varying susceptibility to be present in experimental animals. His only reference to the fundus picture is that the retina may appear anemic.

There are two forms of ergot poisoning, the gangrenous and the convulsive. In the gangrenous form, the patient usually complains first of a general lassitude, vague lumbar pains or pains in the limbs. Soon the intellect becomes dull. After a few weeks, the parts affected become swollen and inflamed and are attacked by violent burning pains (St. Anthony's fire). There are alternating periods of intense heat and intense cold. The skin becomes livid and cold and then numbed. Later the diseased part becomes dry and black, and there may be an auto-amputation. The degree of gangrene varies from a mere shedding of nails to the loss of limbs.

In the convulsive form, the patient has severe fits and muscular contractions. Permanent epilepsy or feeblemindedness is common among the survivors. The mild case is characterized by a feeling of pins and needles through the body and by muscular contractions. It is in this type mainly that ocular complications occur. These consist of dilatation of the pupils, double vision, cataract and inflammation and degeneration of the optic nerves.

REPORT OF A CASE

H. R., an Italian woman, aged 22, was referred by the medical department of the Brooklyn Hospital to the ophthalmologic department (service of Dr. Charles H. Hargitt) on Feb. 26, 1934, because of loss of vision. Her chief complaints at that time were shooting pains in the occipital region of the head and in the left shoulder and arm and loss of vision for the past two months. Her family history was irrelevant. Except for having the usual diseases of childhood, she had never been ill before. She had been married five years and had two children, who were living and well; she had never had any abortions or miscarriages.

About two months before examination she failed to menstruate at the expected time, and a druggist gave her pills each containing 1 grain (0.065 Gm.) of ergot. She took two pills four times a day and no other medication. On the fifth day she began to have severe shooting pains in the back of the head and a severe buzzing in the left ear. The next day she noticed that her sight was blurred. This became progressively worse during the next four weeks and has improved slightly since. Severe burning pains also developed in the back and the left shoulder and arm. In a few days the burning changed to a feeling of intense cold, particularly over the left side of the face. After two weeks the feeling of coldness as well as the buzzing in the ear disappeared.

Physical examination revealed an obese young woman who did not look acutely or chronically ill. Vision was 20/200 in the right eye and 20/50 in the left eye. Vision could not be improved in either eye with glasses. The pupils were equal and regular and reacted to light and in accommodation. There were no ocular palsies or nystagmus. Examination of the fundi showed that the disks were pale

salmon color and elevated about 2 diopters. The margins of the disks were very indistinct, and the retinas immediately surrounding them were edematous. Here and there, the disks showed patches of gray as evidences of beginning secondary atrophy. The arteries were somewhat smaller than normal, but the veins were not unduly overfilled or tortuous. The portions of the vessels on the disks showed perivascular sheathing. No hemorrhages or exudates were visible.

The fields were markedly contracted to a 2/250 mm. white test object. On the Thomasson screen, with a 2/1,000 mm. white target, the blind spots were greatly enlarged, and there were absolute central scotomas extending about 3 degrees around the point of fixation.

A month later, the secondary atrophy had progressed considerably, and the perivascular sheathing had extended along the vessels. Vision was unchanged.

The patient came to the Brooklyn Hospital on January 26, but it was not until she came to the ophthalmologic department a month later that the history of a "missed period" and of the taking of ergot was elicited. In the meanwhile, an exhaustive search was made for the etiologic factor. Syphilis was ruled out because of the history and the negative Wassermann reaction. Encephalitis was ruled out because there was no history of fever or of a "grippal" infection or of transient diplopia and because the results of the neurologic examination were negative. Optic neuritis secondary to focal infection was ruled out because a thorough search failed to reveal such a focus. Hereditary and other neurologic diseases (Leber's disease, multiple sclerosis, etc.) were ruled out by the history and the negative results of the neurologic examination.

HISTORY

The history of ergot is extremely interesting. According to Barger,[5] ergot is a fungus that attacks rye but rarely other cereals. Its history, therefore, is closely associated with the distribution of rye. Rye bread had been eaten by the Teutons and Russians as far back as records go. The Greeks and Romans knew nothing of rye until its cultivation was introduced by the invading Teutons. In the United States, the consumption of rye for bread is almost negligible as compared with the use of wheat. The degree of contamination with ergot depends on the weather at the time of planting. If at that time it is very rainy, and this is followed by a hot spell, the degree of contamination is greatly increased. Ergot deteriorates on standing, so that if infected rye is stored a long time after harvesting, the chances of poisoning with ergot are greatly reduced. For this reason, St. Anthony's fire (ergot poisoning) was recognized even in ancient times as a disease of the poorer class of farmers. This was so particularly after a previous crop failure, as the farmers had to utilize the freshly harvested rye for bread. Up to comparatively recent times, epidemics of ergot poisoning were frequent, jumping from locality to locality and numbering their victims by the thousands. A small epidemic was reported in England[6] as

5. Barger, G.: Ergot and Ergotism, Edinburgh, Gurney & Jackson, 1931.

6. Robertson, J., and Ashly, H. T.: Ergot Poisoning Among Rye Bread Consumers, Brit. M. J. **1**:302 (Feb. 25) 1928.

recently as 1928. It was not until almost modern times that ergot was recognized as the specific poison.

It was noted even among the ancients that in the convulsive type of ergot poisoning spontaneous abortion sometimes occurred. This action was not constant and in fact did not occur in the majority of cases. Many cases were reported in which the poisoning was so severe that death resulted, but abortion of the fetus did not occur. However, ergot first came into use because of its oxytocic properties. It was used empirically by the ancient midwives to bring on labor pains, to shorten the time of labor and to cause abortion of the fetus.

The first written record of the use of ergot in medicine was by Lonicerus,[7] in 1852, who mentioned it for its ability to produce pain in the womb. According to Schelenz,[8] ergot was used in Chinese midwifery at an early date and the Moorish physician Avicenna (980-1037) also knew its uses. Its first entry into official medicine took place in the *Medical Repository,* in which Stearns [9] described his method of administering ergot to shorten parturition. Akerly,[10] in 1809, first mentioned it for its aborting properties. This country was therefore the first to recognize the rational uses of ergot in medicine, and from here it was reintroduced into Europe. Spalding [11] noted the possibility of abortion occurring in animals that had eaten infected rye or wheat. In 1822, Hosack [12] noted that the injudicious use of ergot resulted in an increase in the number of stillbirths, and he caused an inquiry to be made by the Medical Society of New York. He advocated its restriction to control postpartum bleeding. The "United States Pharmacopeia and National Formulary" (1820) was the first official publication to admit ergot.

Dale [13] isolated and showed the pharmacologic factors of the active constituents of ergot, ergotoxine and ergotamine. He showed that they cause primary stimulation of smooth muscle tissue, especially of the arteries, the uterus and the pupils. This reaction is soon followed by muscular paralysis. This action is directly antagonistic to the action of epinephrine. Ergot stimulates the suprarenal glands and tends to prevent hyperglycemia. Because of its paralyzing effects on the sympa-

---

7. Lonicerus, A.: Kreuterbuch, Frankfort-on-Main, M. Lechlern, 1582, chap. 370, p. 285.

8. Schelenz, H.: Geschichte des Pharmazie, Berlin, Julius Springer, 1904, p. 70.

9. Stearns, J.: M. Reposit. **5**:308, 1808.

10. Akerly, S.: M. Reposit. **6**:341, 1809.

11. Spalding, L.: New England J. Med. & Surg. **7**:145, 1818.

12. Hosack, D.: Essays on Various Subjects of Medical Science, New York, J. Seymour, 1824, vol. 2, p. 295.

13. Dale, H. H.: Action of Ergotoxine; Existence of Sympathetic Vasodilators, J. Physiol. **34**:163, 1906.

thetic nerves, it lowers the basal metabolism. Its use has therefore been advocated for the treatment of diabetes (Rothlin [14] Minkowski,[15] Moretti [16] and Boukaert and Schaus [17]) and of hyperthyroidism (Marine and co-workers,[18] Epstein,[19] and Abderhalden and Wertheimer).[20] Trautmann [21] and Tzanck [22] advocated its use in certain cases of migraine. Its use has also been advocated for the treatment of glaucoma, particularly of the chronic form.

The mechanism by which ergot produces its effects on the eye is not quite clear. Meier [1] stated that cataract is the result of tonic and clonic contractions of the ciliary muscles, and he likened the effect of ergot to the formation of cataract in a child after convulsions. In this connection, it is interesting to note that A. Fuchs [23] expressed the belief that the frequent increase of tetany in children during the spring in Austria is due to a mild form of ergot poisoning. Orlow [24] maintained that cataract is due to a direct poisoning of the capsular epithelium and that amblyopia is the result of a direct poisoning of the retina and not to a vasoconstriction of the retinal vessels. However, Kortneff [3] described a number of cases of acute anemia of the retina in which there was contraction of the vascular trunks. Kaunitz,[25] experimenting with cocks, produced effects suggestive of vasomotor and trophic diseases. There were organization of the thickened intima of the vessels and occlusion by organized thrombi.

---

14. Rothlin, E.: Specific Action of Ergot Alkaloids on the Sympathetic Nervous System, J. Pharmacol. & Exper. Therap. **36**:657 (Aug.) 1929.

15. Minkowski, O.: Insulin Treatment of Diabetes, Med. Klin. **22**:479 (March 26) 1926.

16. Moretti, H.: L'action hypoglycemiante de l'ergotamine dans le diabète, Compt. rend. Soc. de biol. **97**:320 (July 8) 1927.

17. Boukaert, J. P., and Schaus, J.: Ann. Soc. sc., Bruxelles (series C, sc. med.) **40**:81, 1927.

18. Marine, D.; Deutch, M., and Cipra, A.: Effect of Ergotamine Tartrate on Heat Production of Normal and Thyroidectomized Rabbits, Proc. Soc. Exper. Biol. & Med. **24**:662 (April) 1927.

19. Epstein, E. Z.: Ueber die Beeinflussung der Thyroxindiurese durch Schlafmittel und andere Pharmaka, Arch. f. Exper. Path. u. Pharmakol. **142**:214, 1929.

20. Abderhalden, E., and Wertheimer, E.: Beziehungen der Thyroxinwirkung zum sympathischen Nervensystem, Arch. f. d. ges. Physiol. **216**:697, 1927.

21. Trautmann, E.: Die Beeinflussung migräneartiger Zustände durch ein sympathikushemmendes Mittel (Gynergen), München. med. Wchnschr. **75**:513 (March) 1928.

22. Tzanck, A.: Le traitement des migraines par le tartrate d'ergotamine, Bull. et mém. Soc. méd. d. hôp. de Paris **52**:1057 (June 28) 1928.

23. Fuchs, A.: Ergotismus and Tetanie, Wien. klin. Wchnschr. **28**:494, 1915.

24. Orlow, A.: Nevrol. vestnik **9**:304, 1905; abstr., Arch. f. Augenh. **53**:9, 1905.

25. Kaunitz, J.: Chronic Endemic Ergotism: Its Relation to Thrombo-Angiitis Obliterans, Arch. Surg. **25**:135 (Dec.) 1932.

CONCLUSION

From the symptoms, the case reported here can be classed as one of mild gangrenous ergot poisoning. The picture presented by the fundi may be explained according to the findings of Kaunitz.[25] With the increasing use of ergot in medicine, it is well to bear in mind that in susceptible persons, small doses may cause serious symptoms.

METASTASIS IN THE CHOROID FROM ADENOCARCINOMA OF THE TESTIS

ISADORE GOLDSTEIN, M.D.
AND
DAVID WEXLER, M.D.
NEW YORK

The most frequent primary source of metastatic carcinoma of the choroid is the female breast. In the cases collected by Krukenberg [1] and Behr [2] about 70 per cent of the metastatic lesions originated from this organ. A later estimate by Usher [3] indicated a similar incidence in a larger group of cases. The lung and the stomach are next in order of frequency as primary seats of the growths, while isolated instances have been reported of tumors metastatic from the liver, the mediastinum, the thyroid gland, the suprarenal glands and the prostate.[4]

The case to be described differs from those previously reported in that the primary malignant growth was an adenocarcinoma of the testis. This tumor belongs to the group of teratoid tumors of the testis. These embryonal tumors in which there is a sudden overgrowth of primary elements of the germ layer are highly malignant. While in this case, that of a child aged 4 years, only the epithelial element was involved, growths of this class may involve several types of mesodermal or entodermal elements.

REPORT OF A CASE

History.—A. C., aged 4 years, was admitted to the service of Dr. Béla Schick with the history that an orchidectomy had been performed for adenocarcinoma of the right testicle eighteen months before. The diagnosis was verified by histologic examination. The child was well until six weeks prior to admission, when he began to suffer from cough, dyspnea and fever.

Physical Examination.—In addition to signs pointing to an infiltration at the base of the right lung there was enlargement of the supraclavicular lymph nodes and of the spleen. The right testicle was absent. Roentgen examination of the chest showed a massive enlargement of the intrathoracic lymph nodes and an infiltrative process at the base of the right lung. These lesions were considered

---

From the Laboratories and Ophthalmological Division of the Mount Sinai Hospital.

Read at the Ophthalmological Section of the New York Academy of Medicine, Oct. 15, 1934.

1. Krukenberg: Klin. Monatsbl. f. Augenh. **41**:145, 1903.
2. Behr: Klin. Monatsbl. f. Augenh. **79**:788, 1922.
3. Usher, cited by Hudson.[4]
4. Hudson, A. C.: Metastatic Carcinoma of the Choroid, Arch. Ophth. **11**:916 (May) 1934.

Fig. 1.—Cross-section of the globe, actual size.

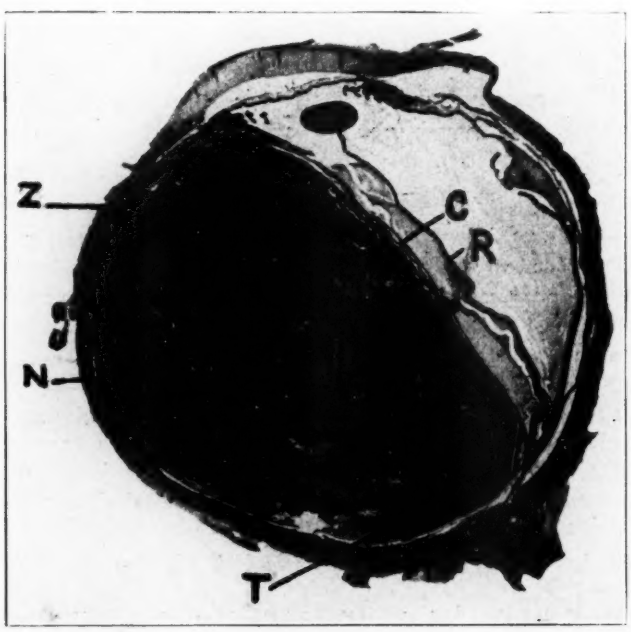


Fig. 2.—Cross-section of the tumor. *R* indicates the retina, and *C*, the choroid, both detached; *T*, a definitive tumor; *N*, a necrotic portion of the tumor, and *Z*, a more intense zone of necrosis adjoining the infiltrated sclera.

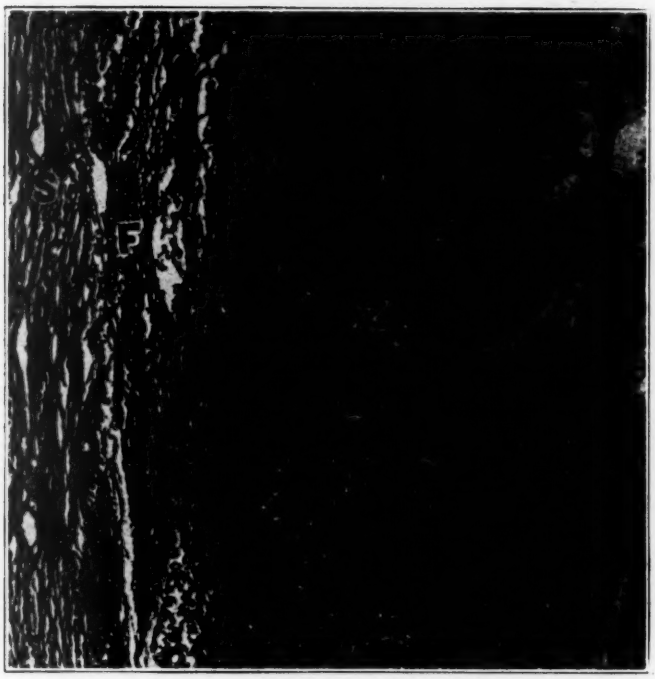


Fig. 3.—Section of the tumor adjoining the anterior portion of the sclera. *S* indicates the sclera; *F*, infiltration with carcinoma cells and polymorphonuclear leukocytes, and *Z*, an intensely necrotic portion of the tumor.

Fig. 4.—Section of the tumor showing the suprachoroidal situation. *C* indicates the choroid; *CA*, the carcinoma, and *N*, a necrotic area.

metastatic from the primary malignant growth of the testicle. Radiotherapy was undertaken, with but little improvement in the symptoms.

Ocular Status.—The fundi, examined by the house physician, appeared normal on admission. Five weeks later it was noted that the conjunctival vessels of the right eye were markedly dilated and that the eye was red. The globe was somewhat prominent, but hardly to the point of showing definite proptosis. Examination of the media showed a large solid detachment of the entire right half of the retina, extending from a point close to the disk as far forward as one could see. The detachment was uniform and contained but one or two folds. Neither pigment nor hemorrhagic spots were visible on its surface. The vitreous was clear nasally. The fundus at the posterior pole was seen with the —18 lens of the ophthalmoscope. The left eye was emmetropic, or nearly so. The myopia in the right eye was considered of mechanical origin, probably being a result of weakening of the sclera incident to its invasion by the new growth. Subsequently the conjunctiva became edematous to the extent that it protruded beyond the palpebral fissure.

Course.—The general condition grew rapidly worse as the pulmonary symptoms increased, and the child died seven weeks after admission.

Postmortem Examination.—The right globe together with 5 mm. of nerve was obtained shortly after death. The eye was sectioned at once anteroposteriorly and revealed a friable chocolate-brown mass arising from the choroid and filling the temporal two thirds of the vitreous. The globe measured 32.5 mm. anteroposteriorly and 34 mm. at the equator. The specimen was fixed in Bouin's solution,[5] and sections were prepared in paraffin. Staining was done with hematoxylin and eosin.

Status Eighteen Months After an Orchidectomy for Adenocarcinoma of the Right Testicle: The pathologic diagnosis was: metastases in the retroperitoneal, cervical and mediosternal lymph nodes, with infiltration into the trachea, right bronchus, the upper, medial and lower lobes of the right lung and the lower lobe of the left lung.

Microscopic Structure: The tumor lay between the choroid and sclera and extended from the nasal side of the disk to the root of the ciliary body, where the pars plana and muscular ciliary structure had been dislocated forward by the growth. The definitive portion of the tumor consisted of small, loosely arranged groups of deeply-staining polyhedral cells separated by cellular connective tissue. These elements comprised about one third of the tumor. The largest part of this tissue was situated at the posterior pole, while smaller fragments were scattered throughout the growth anteriorly. The remaining portion of the growth was a more compact mass of necrotic tissue, amorphous in appearance and for the most part staining feebly with eosin. Included in this area were the less viable portions of the tumor, a few poorly developed blood vessels, strands of embryonal connective tissue and some polymorphonuclear leukocytes. Adjoining the sclera the necrotic zone was denser and stained more deeply. In the region behind the root of the ciliary body the deep scleral fibers were infiltrated with cells of the carcinoma and with many polymorphonuclear leukocytes.

The vascular layers of the choroid were entirely free from tumor tissue and were otherwise intact. A search for tumor cells in the choriocapillaris gave negative results. However, the posterior layers (lamina fusca) were densely infiltrated

5. This solution was made up as follows: solution of formaldehyde, U. S. P., 500 cc.; distilled water, 1,500 cc.; glacial acetic acid, 100 cc., and trinitrophenol to the point of saturation.

in the entire extent of the choroid. A definite zone of these connective tissue elements of the choroid was seen next to the sclera, where they formed a capsule for the tumor. The pars plana had been invaded, but the ciliary body was not involved by the growth.

COMMENTS

Perhaps the most striking feature in this case is the situation of the tumor in the suprachoroidea. It appears that the starting point for the new growth was in the posterior, connective tissue section of the choroid and that further growth proceeded in the direction of the sclera, causing detachment of the choroid and, with it, of the retina. That the choroid proper was not involved is most unusual, for this portion usually bears the brunt of metastatic tumors. Of interest also is the enlargement of the globe. In explanation of this one may point not only to the rapid growth of the tumor, a characteristic of embryonal tumors in general, but to the influence of the necrotic tissue on the sclera. The necrotic zone was most intense in the outer portion of the tumor and was responsible for the symptoms of deep scleritis which called attention to the presence of the metastatic growth.

AGE AS AN IMPORTANT FACTOR IN THE AMOUNT OF LIGHT NEEDED BY THE EYE

C. E. FERREE, PH.D.

G. RAND, PH.D.

AND

E. F. LEWIS, A.B.

BALTIMORE

In any consideration of the effect of an increase in the intensity of light on the visibility of objects the following principles should be borne in mind. Roughly speaking, objects are seen because of their size and their difference from the background. With a given physical difference from the background, i. e., a given difference in the coefficient of reflection, the apparent or sensation difference increases rapidly with an increase in the intensity of light. This difference is greater in the case of white on black or light objects on a dark background than for black on white or dark objects on a light background. Whether there is also an effect on the apparent size of the object has not yet been fully determined. It is well known that an increase in the size of the object functions in some unknown relation as an increase of brightness, but the converse of this has not received much attention. The effect, if any, is probably small.

An increase in the intensity of light also has an important effect on the clearness of the image formed. This effect is produced through its action on the size of the pupil. The size of the pupil affects the clearness of the image in the following ways: 1. The breadth of the cross-section of the cone of light from each point in the object is changed. As it is decreased, for example, the blurring of the image caused by the presence of diffusion circles is decreased. Always an important factor in the sharpness of the image formed, this effect becomes especially pronounced when there is a fault in the focusing action of the refractive system. As will be shown in another paper by two of us in collaboration with M. I. Smith, pupils from 1.2 to 2 mm. in breadth render the eye practically independent of errors of refraction and also practically independent of changes in accommodation. From this it can be readily seen that the decrease in the size of the pupil caused by high intensities of light is of great service to the presbyopic eye. In the case of presbyopic eyes we have found the distance

From the Research Laboratory of Physiological Optics, Wilmer Ophthalmological Institute, Johns Hopkins Medical School.

of the near point to be changed as much as 73 per cent by a change from 1 to 25 foot-candles of light and the apparent powers of accommodation to be increased as much as 4.3 diopters in certain parts of the scale.[1] The range of distance over which a presbyopic person can see with a given pair of bifocal glasses is also greatly increased by an increase in the intensity of light, especially in cases of advanced presbyopia. Persons with advanced presbyopia are in great need of this increase in the power to see at different distances.

2. The effect of diffraction on the clearness of the image is changed. The effect of diffraction is to cause the rays near the edge of the pupil to form faint circles or bands about each point in the image. The breadth of the entire diffraction pattern, consisting of a central disk and concentric rings, sustains an inverse relation to the size of the pupil. This effect tends to counteract the beneficial action of the contraction of the pupil mentioned previously. It does not, however, become of considerable consequence until unusually small sizes of pupil are reached, much smaller than occur as a reaction to any range of intensity of light that is apt to be used. In recent determinations we found, for example, that the values which have been assigned to the optimum breadth of the pupil were in most cases too high and in one case much too high. The error in former determinations may have been due in part to the use of an artificial pupil too far in front of the eye or to other undesirable features in its construction and placement. Also, in the case in which the value was excessively high, a mydriatic was not used in making the determination. This is not usually considered safe technic.

3. The aberration and other irregularities of focusing resulting from the use of the periphery of the lens and cornea are excluded by pupils of small and medium size. The spherical aberration ordinarily found in a refractive system as strong as is present in the eye is enormous. While the flattening of the lens and the decrease in the refractive index toward the periphery act as a correction, there remains a considerable amount of this defect in all eyes. Also, with advancing age changes in density occur which are unequally distributed throughout the lens. Thus by decreasing the size of the diffusion circles in the image and by limiting the aperture to the most favorable portions of the refracting system, the pupil acts as a final corrective of all defects in focusing.

Reduction in the size of the pupil may exert a secondary effect on the clearness of the image. In passing to the retina a certain percentage of light, variable from eye to eye, is scattered by internal reflections within the media. This scattered or unfocused light tends to blur or

1. Ferree, C. E., and Rand, G.: Effect of Intensity of Light on the Near Point of Vision and a Comparison of the Effect for Presbyopic and Non-Presbyopic Eyes, Tr. Illumin. Engin. Soc. **28**:590, 1933.

confuse the image and, when present in sufficient amount, causes the phenomenon known as veiling glare. By reducing the area of the cornea acted on, the cross-section of the beam throughout and the variety of angles at which the rays of light may strike the bounding surfaces of the media and various reflecting particles and surfaces to be found in the media, a small pupil over and above the effect on the amount and intensity of light reaching the retina may serve to reduce the overlay of scattered light in the image. In any event, the use of such an aperture before an eye that would be classed as emmetropic noticeably clears up vision under light of moderate and high intensities in spite of the reduction of the intensity of the useful light in the image. This may not be due entirely to an improvement in the focusing.

There is much greater need of the higher intensities of light for old than for young eyes. Among the reasons why an old eye needs more light, and for that reason derives more benefit from an increase in the amount of light, the following five may be mentioned: its smaller pupil, the inferior imaging power of its refracting media, the diminished transparency of the media, the decay in all its processes of adaptation and adjustment and the failing powers of the retina itself.

In this connection, it may be noted that while the great need of old eyes for high intensities of light is perhaps the chief reason for stating that old eyes derive more benefit from an increase of intensity than young eyes, it is not the only reason, as will be shown later in the paper. That is, when measured in percentage, the increase in acuity produced by increasing intensity of light through the range of intensities employed in our experiments was in general greater for the old than for the young eyes. For the three observers in the early and middle stages of presbyopia it was much greater; for the observer 70 years of age it was greater only over certain ranges in the scale.

In the treatment of the presbyopic eye the refractionist is apt to consider only the refractive and accommodative situation. The physician, however, must take all the functions of the eye into account. The errors in refraction and the failure of accommodation are not the only defects in the old eye which can be remedied in the prescription given. All the possible refractive corrections that can be given to the presbyopic eye will not clear up the media nor add to the discriminative powers of the sensorium.

It is in part the purpose of this study to show that for these deficiencies there is a simple treatment which lies within the power and province of the medical examiner to prescribe, namely, the supplying of the intensity of light which is required to give the eye the acuity which in his judgment it is feasible and advisable to attain. It would also be of great service to the intelligent patient to know what acuity

he is able to obtain at different intensities of light and, therefore, what type of work he may hope to be able to do and what intensity of light he needs to be able to do this work. All that is required to render this service is that the examination be made at a sufficient number of intensities of light selected with reference to the case in question, that the results be given to the patient and that recommendations be made within the judgment of the examiner. That is, there is to be included in the prescription given to the patient a correction not only for the image-forming function but for the other functions which make the eye an organ of vision.

Several years ago two of us (C. E. F. and G. R.) pointed out the advantages of variable illumination for the tests and examinations that are made in the refraction clinic.[2] Three of these advantages were: (*a*) the superior sensitivity of the acuity test for the detection of errors of refraction and for the selection of the optimum correcting glass at low illumination as compared with high illumination; (*b*) the much greater sensitivity of the illumination scale than the visual angle scale for the detection and correction of low astigmatism, and (*c*) the greater sensitivity of tests for astigmatism of the radial line type at high intensities of illumination. To these we wish to add at this time a still further important use, namely, the determination of the intensity of light which a presbyopic person should have to give him good acuity.

Also an instrument[3] was described for the uniform illumination of acuity charts and test objects in which the intensity of light could be varied in continuous change without change in the color or composition of the light. This instrument is now available to the public in a conveniently operable form with a calibrated scale of intensities delivered to the chart ranging from 0 to 50 foot-candles. They have further constructed and are using a conveniently portable device with which the intensity of illumination on the work can be varied in continuous change over a still wider range without alteration in color and composition of light and without change in the size, shape or position of the illuminated area or in the evenness of distribution of light within that area.[4] The purpose of this device is that the amount of light needed and preferred for different types of work and for different types and ages of eye

2. Ferree, C. E., and Rand, G.: Visual Acuity at Low Illumination and the Use of the Illumination Scale for the Detection of Small Errors in Refraction, Am. J. Ophth. **3**:408, 1920; Intensity of Illumination and Other Factors Influencing the Sensitivity of the Radial Line Test for Astigmatism, ibid. **12**:809, 1929.

3. Ferree, C. E., and Rand, G.: Lantern and Apparatus for Testing the Light Sense and for Determining Acuity at Low Illuminations, Am. J. Ophth. **3**:335, 1920.

4. Ferree, C. E., and Rand, G.: Lamp for Determination and Measurement of the Preferred Intensity of Light for Reading and Other Work, Arch. Ophth. **12**:45 (July) 1934.

may be determined in situ. The device is also provided with a calibrated scale of intensities from which the amount of light delivered can be read at any time, thus serving the purposes both of a variable illuminator and of a light meter. It is also particularly useful in the care and servicing of presbyopic eyes because of the great individual variation in the amount of light that is needed for such eyes.

Not only in presbyopia but in every refractive anomaly that comes under advisement, two important avenues of treatment are open: the correction of the refractive system to form as clear an image as possible and the correction of lighting conditions to give the retina the optimum power to discriminate detail in the image. At best the refractionist can go only so far in the task set to him. It remains for the lighting specialist to minimize the harm of the residual refractive defects. A great deal indeed can be done along these lines. Colorless light, a glareless field correctly balanced as to distribution of brightness, good diffusion to give a minimum of glare on the work and optimum intensity will go a long way in improving the vision and health of any eye. The care and treatment of the defective and sick eye is an important field in lighting and one that is as yet undeveloped. Its development, it is scarcely needful to say, belongs by right and duty to the physician working in cooperation with the lighting specialist. In case of sick and defective eyes the effects of bad lighting are almost unbelievably extreme to those who have not had personal experience or the chance to observe the effect on others.

In partial fulfilment of the program which we have planned in the interests of a better understanding of the needs of the presbyopic eye and a better knowledge of ways to improve its functions and add to its comfort, it has been our purpose in this study to make the following determinations: (1) the effect of a change of intensity over a wide range on the acuity of both presbyopic and nonpresbyopic eyes, (2) the amount of light required by both types of eye to give certain selected values of acuity and (3) the percentage increase in acuity for both types of eye with an increase of intensity over a wide range, from 0.5 to 100 foot-candles.

METHOD

The test objects used in conducting the experiments were broken circles, the openings of which (the details to be discriminated) subtended angles at the eye of 2.4, 1.8, 1.2, 1.08, 0.96, 0.84, 0.72, 0.60, 0.48 and 0.36 minutes, respectively, of an arc at 6 meters. These test objects were mounted in turn as needed at the center of a rotatable disk, 12.4 cm. in diameter, surfaced with white paper of the same coefficient of reflection as the paper on which the test objects were printed. One of them is shown in figure 1 *A*. To provide an objective check on the judgment, the opening of the broken circle was turned in haphazard order into eight positions (0, 45, 90, 135, 180, 225, 270 and 215 degrees), and a correct judgment of the position of the opening was required in five of the eight positions. Visual acuity

was rated as the reciprocal of the smallest visual angle that could be thus discriminated.

In order to secure accuracy of location of the test object in the eight positions, an octagonal metal plate of suitable breadth and thickness was mounted on the other end of the axle which held the disk. Between this plate and the disk on which the test object was mounted was a small brass cylinder flattened on its upper surface. The axle passed through a circular aperture extending from front to back through the center of this cylinder, which was mounted on a vertical rod and clamped to a small table. On the flattened surface of the cylinder was fastened in a horizontal position a steel lamina 2.8 cm. long and of a breadth equal to the length of one of the sides of the octagonal plate. As the plate was rotated, the lamina, by engaging each of the sides in turn, served as a stop for the test object in the eight desired positions. For convenience of turning, a handle of suitable length was attached in a radial position to the axle just back of the octagonal plate. This device is shown in figure 1 *B*.

Six intensities of light were used on the test surface, 0.5, 1, 5, 10, 25 and 100 foot-candles. This light was of daylight color, giving the spectrophotometric

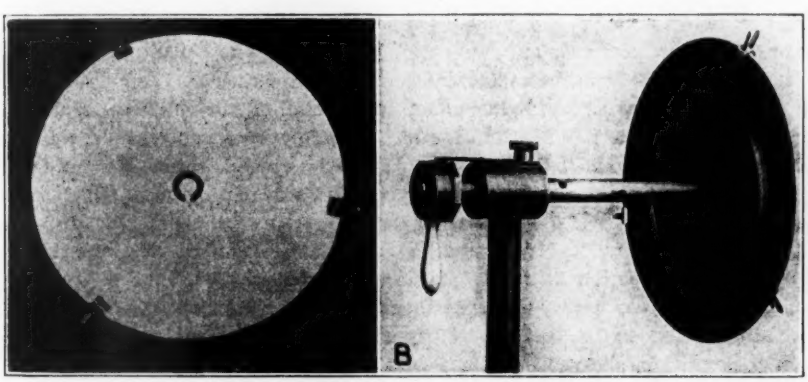


Fig. 1.—*A*, one of the test objects mounted in position for use; *B*, the device for securing accurate location of the test object in the eight cardinal positions.

curve required in artificial daylight filters. The units employed were the large and small studio units. The changes of intensity were produced by suitable changes in the distance of the units from the test surface. Each test was preceded by a fifteen minute period of adaptation to the intensity of illumination to be used.

The test was begun for each observer and each intensity of illumination with the size of test object that was nearest the threshold of acuity for that observer and that intensity of illumination. The changes in visual angle that were needed to give the threshold of acuity for each intensity were produced by changing the distance of the eye from the test object. In order to produce these changes with sufficient fineness and precision, the mouth bit bearing the impression of the observer's teeth hardened in wax was mounted on a support consisting of a heavy metal base with beveled edges. This base was moved back and forth in a grooved track by a coarse-threaded screw. From the breadth of the opening of the circle and the distance of the test object from the eye the visual angle subtended was computed in each case. The breadth of the opening of the circle was measured on a micrometer comparator. In each case a sufficient number of determinations

was made to give an adequate measure of acuity. The number of determinations required is much reduced if due care is taken to prevent fatigue and to maintain a constant state of adaptation and time of exposure of the test object. In order to minimize as far as possible the effect on acuity of changing the visual angle by changing the distance of the object, all changes of distance were made beyond 6 meters. The effect on the size of the image formed on the retina by the shift in the nodal point in the act of accommodating was thus eliminated. There remained only the possible sensory effect on acuity of the distance to which the image was projected. This has been discussed in former papers.[5] It was thought not to be a factor of serious consequence in connection with the present experiments, especially since this effect of distance, if present within the range of distances used, would be expected to be slight in comparison with the effect of intensity of light; and the difference in the effect from eye to eye, very slight in comparison with the effect of difference of intensity on young and old eyes. The factor could have been eliminated entirely by using the apparatus[6] devised by two of us (G. E. F. and G. R.) some years ago for changing both the size of the object and the intensity of illumination in continuous series, but circumstances were such that it was not possible to use that apparatus at this time. The method of change of distance beyond 6 meters was thought to be sufficient for the comparisons that were to be made.

The investigation was prompted by several considerations. Among these, the following may be noted: (1) the effect in general of the intensity of light on acuity, (2) age as a factor in this effect, (3) the determination of equivalent intensities for young and for old eyes, i. e., intensities which give the same acuity for these eyes, (4) the acquisition of a better knowledge of how much can be expected from an increase of intensity in the mitigation of the effect of an increase of age on the powers of vision and (5) a demonstration of the importance of adding the determination of acuity at different intensities of light to the routine examination of presbyopic eyes and of including information on this point with the prescription given to the patient. It is extremely important to the presbyopic person to know that he can still do a fair amount of the ocular work commonly assigned to younger people by so simple an expedient as using a suitably high intensity of light.

From the total number of cases studied, it has been considered sufficient to select the data obtained from seven for purposes of presentation here: the cases of three persons with emmetropia and of four with presbyopia. The ages of these observers were 25, 27, 27, 42, 54, 68 and 70, respectively. During the experiments they all wore their refractive correction for distant vision. While the study could be made with profit on a larger number of observers, we feel that the selection we have made is sufficient to indicate the great practical importance of giving more attention to intensity of light as a factor in caring for the welfare and efficiency of the eyes of the old and the middle-aged.

---

5. Ferree, C. E., in discussion on Ives, H. E.: The Measurement of Brightness and Its Significance, Tr. Illumin. Engin. Soc. **9**:192, 1914. Ferree, C. E., and Rand, G.: Distance of Projection of the Visual Image in Relation to Its Apparent Intensity, Am. J. Psychol. **43**:678, 1931; Ways in Which Distance of the Test Field Affects Determinations of Retinal Sensitivity, Arch. Ophth. **7**:383, 1932.

6. Ferree, C. E., and Rand, G.: An Acuity Apparatus with Attachments for Testing the Light and Color Sense and for Color Mixing, Arch. Ophth. **55**:245, 1926.

RESULTS

The results obtained are given in tables 1 and 2 and figures 2 and 3. In figure 2 are given the intensity-acuity curves and in table 1 the data from which they were plotted. In figure 2 *A* are given the curves for

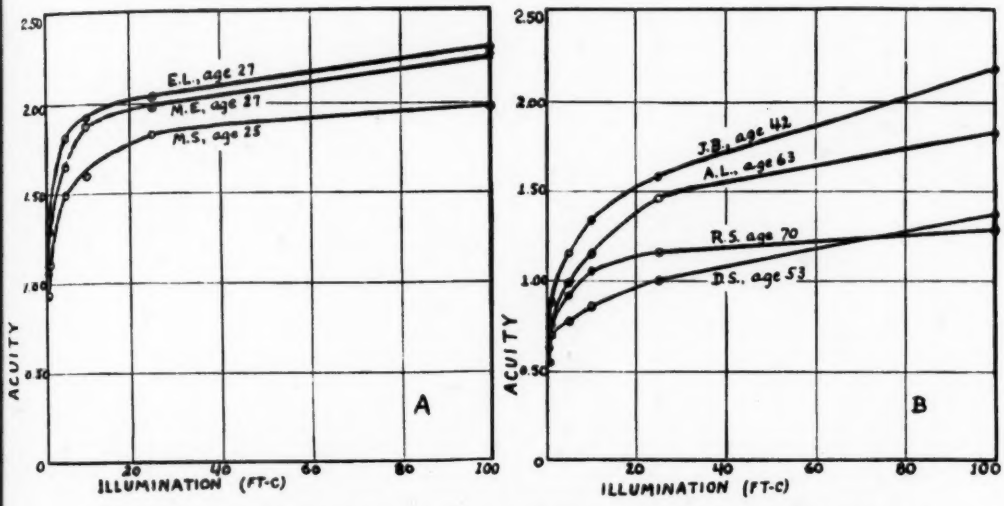


Fig. 2.—Curves showing the effect of increase of illumination on acuity: *A*, for three nonpresbyopic observers; *B*, for four presbyopic observers. The range of illumination was, from 0.5 to 100 foot-candles.

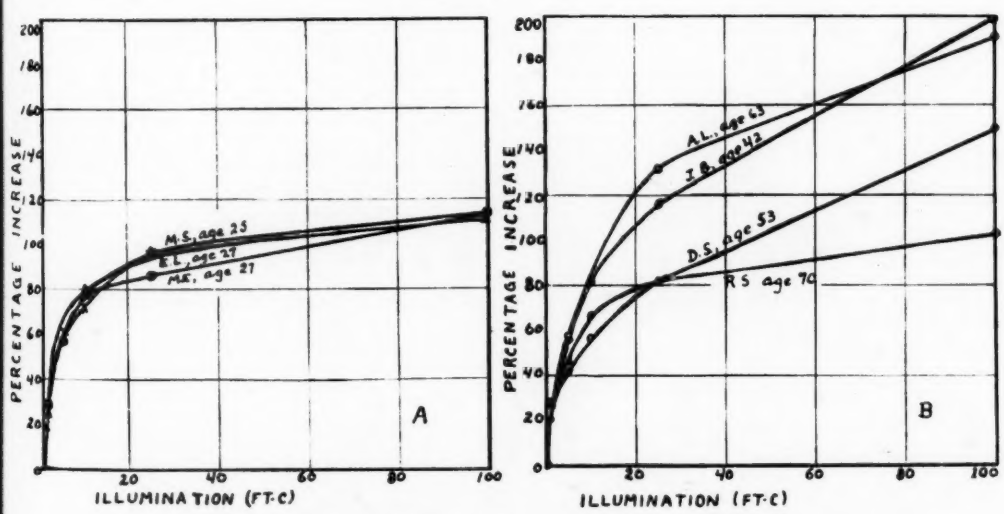


Fig. 3.—Curves showing the effect (in percentage) of an increase in the intensity of light on acuity, the acuity at 0.5 foot-candles being taken as the base: *A*, for three nonpresbyopic observers; *B*, for four presbyopic observers.

the nonpresbyopic observers, E. L., M. E. and M. S., and in *B* those for the presbyopic observers, J. B., A. L., D. S., and R. S.[7] As stated earlier in the paper, only the correction for distance was worn during the test. For all the observers the tests were made for both eyes.

From these curves the illumination required to give successive tenths of acuity from 0.5 to the value attained at the highest intensity of illumination used, 100 foot-candles, was read for each observer. These values are given in table 2.

The curves in figure 2 and the data given in table 2 show striking differences in the results for the two groups of observers. With reference to these curves and data, the following points may be noted:

1. There is a great difference in the level of the curves for the two groups, especially at the lower intensities. This fact can be given a more

TABLE 1.—*Acuity of Nonpresbyopic and Presbyopic Observers (Both Eyes) and Percentage Increase in Acuity with Increase of Intensity of Illumination* *

Illumination (Foot-Candles)	Acuity							Percentage Increase						
	Nonpresbyopic Observers			Presbyopic Observers				Nonpresbyopic Observers			Presbyopic Observers			
	E.L., Aged 27	M.E., Aged 27	M.S., Aged 25	J.B., Aged 42	A.L., Aged 63	D.S., Aged 53	R.S., Aged 70	E.L., Aged 27	M.E., Aged 27	M.S., Aged 25	J.B., Aged 42	A.L., Aged 63	D.S., Aged 53	R.S., Aged 70
0.5	1.09	1.06	0.93	0.73	0.63	0.55	0.63	..	..	..	..	..	..	..
1.0	1.35	1.28	1.11	0.88	0.76	0.70	0.76	24	21	19	21	21	27	21
5.0	1.82	1.66	1.49	1.15	0.98	0.78	0.92	67	57	60	58	56	42	46
10.0	1.93	1.88	1.60	1.33	1.14	0.86	1.05	77	78	72	82	81	57	67
25.0	2.04	1.98	1.83	1.58	1.46	1.00	1.15	87	87	97	116	132	82	83
100.0	2.30	2.26	1.98	2.18	1.83	1.37	1.28	111	113	113	199	191	150	103

* In computing percentage increase the acuity at 0.5 foot-candles was taken as the base. The test object was a broken circle.

interesting application perhaps by selecting certain well known values of acuity and showing the amounts of illumination required to attain this acuity. For example, the illumination required by the younger and the older observers to give an acuity of 1 (the Snellen norm), of 1.2 (the equivalent of the next to the last line on many of the standard letter charts) and of 1.5 (the equivalent of the last line on these charts) may be seen at a glance in table 3.

7. The refractions for these observers were as follows:

E. L.: R. E., −1.75 sph. ⊃ −0.25 cyl., axis 25°
L. E., −1.75 sph. ⊃ −0.37 cyl., axis 155°

M. E.: R. E., +0.25 sph. ⊃ +0.25 cyl., axis 90°
L. E., +0.25 sph. ⊃ +0.25 cyl., axis 90°

M. S.: R. E., +0.25 sph. ⊃ +0.37 cyl., axis 165°
L. E., +0.37 sph.

J. B.: R. E., +1.50 sph. ⊃ +0.25 cyl., axis 30°
L. E., +1.75 sph.
For near, add +0.75 sph.

A. L.: R. E., +2.25 sph.
L. E., +2.25 sph. ⊃ +0.25 cyl., axis 180°
For near, add +2.25 sph.

D. S.: R. E., no glasses for distance
L. E., no glasses for distance
For near, add +2.25 sph.

R. S.: R. E., +1.50 sph. ⊃ +0.75 cyl., axis 180°
L. E., +1.50 sph.
For near, add +2.25 sph.

It is seen that two of the older observers were not able to attain an acuity of 1.5 even at 100 foot-candles. Their acuities at this intensity were 1.37 and 1.28, respectively.

2. There is a difference also in the shape of the curves for the two groups. For the younger observers the curves rise sharply at the lower intensities, the knee occurring around 10 foot-candles; for three of the older group (J. B., A. L., and D. S.) the curves rise more gradually and the knee is less pronounced. It occurs in general around 20 foot-

TABLE 2.—*Illumination Required to Give Successive Tenths of Acuity for Nonpresbyopic and Presbyopic Observers (Both Eyes)* *

	Illumination (Foot-Candles)						
	Nonpresbyopic Observers			Presbyopic Observers			
Acuity	E.L., Aged 27	M.E., Aged 27	M.S., Aged 25	J.B., Aged 42	A.L., Aged 63	D.S., Aged 53	R.S., Aged 70
0.5	....	....	....	....	....	0.5	....
0.6	....	....	....	....	....	0.8	0.5
0.7	....	....	....	....	0.6	1.0	0.6
0.8	....	....	....	0.5	1.5	6.0	1.6
0.9	....	....	0.5	1.0	3.4	13.5	4.1
1.0	....	0.5	0.7	2.4	5.7	25.0	7.7
1.1	0.5	0.6	1.0	4.0	8.7	43.0	15.5
1.2	0.6	0.8	1.6	6.2	12.1	65.0	48.0
1.3	0.8	1.2	2.5	8.7	16.4	86.0	
1.4	1.2	2.0	3.6	12.8	21.5		
1.5	1.6	2.8	5.3	18.0	29.0		
1.6	2.2	4.0	8.0	27.0	50.0		
1.7	3.0	5.7	12.0	37.0	69.0		
1.8	4.5	8.0	21.0	50.0	90.0		
1.9	7.3	12.0	49.0	64.0			
2.0	16.0	28.0	....	76.0			
2.1	40.0	55.0	....	89.0			
2.2	70.0	86.0					
2.3	100.0						

* The test object was a broken circle.

TABLE 3.—*Illumination at Which the Acuities Were Attained (Foot-Candles)*

	Younger Observers			Older Observers			
Acuity	E.L.	M.E.	M.S.	J.B.	A.L.	D.S.	R.S.
1.0	0.5	0.5	0.7	2.4	5.7	25.0	7.7
1.2	0.6	0.8	1.6	6.2	12.1	65.0	48.0
1.5	1.6	2.8	5.3	18.0	29.0		

candles. For the three younger observers the acuity attained at 10 foot-candles was, respectively, 84, 83 and 81 per cent of the value attained at 100 foot-candles, while for the three younger members of the presbyopic group the acuity attained at 10 foot-candles was only 61, 62 and 63 per cent of the value obtained at 100 foot-candles. The curve for the oldest member of the presbyopic group, R. S., aged 70, conforms in shape to that for the younger group but is at a much lower level throughout. For him, as is in general the case for the younger group, 82 per cent of the acuity attained at 100 foot-candles was reached at 10 foot-candles.

3. The difference in level between the curves for the group of young observers and those for three of the presbyopic group decreases rapidly as the intensity of light is increased. This is due to the continuous rise of the curves with an increase of intensity of light up to 100 foot-candles for the presbyopic observers and the comparatively small amount of rise beyond foot-candles for the young observers. For the oldest of the presbyopic group, R. S., aged 70, there is a reversal of type, i. e., the rise of the curve beyond the knee is comparatively slow. The general level of this observer's curve, however, is so much lower than that for the nonpresbyopic persons that it is obvious that he needs to take advantage of all the improvement he can feasibly obtain by the use of high intensities of light. The mitigation of the effects of an increase in age by an increase in the intensity of light for the presbyopic group of less extreme age is striking. For example, the acuity at 5 foot-candles for the three younger members of the older group averaged 58 per cent of the average value for the group of young observers at the same intensity of illumination; at 10 foot-candles it averaged 62 per cent; at 20 foot-candles, 67 per cent; at 40 foot-candles, 72 per cent and at 100 foot-candles, 82 per cent. For R. S., aged 70, however, the acuity for these illuminations was 56, 57, 58, 59 and 59 per cent, respectively. The average acuity attained by the younger observers at 100 foot-candles was 2.3, 2.26 and 1.98, respectively; by the four older observers, 2.18, 1.83, 1.37 and 1.28. All of these values, even those for the observer 70 years of age, are, it will be noted, considerably above that given by Snellen as the norm or standard of acuity. In this connection, it may be noted too that some refractionists, whatever intensity of light they may have on their chart, do not attempt or take the trouble to correct eyes, young or old, to give values higher than that selected by Snellen as the standard.

4. Points representing equivalent intensities of light, i. e., intensities which give the same acuity, may be found on the two sets of curves. For example, the average acuity of the three younger observers at 5 foot-candles was 1.66. Two of the older group were able to attain this acuity at higher intensities of light—one, aged 42, at 30 foot-candles, and the other, aged 63, at 60 foot-candles. The average acuity of the three younger observers at 2.5 foot-candles was 1.48. The former of the two older observers had this acuity at 17 foot-candles, and the latter at 27 foot-candles. The average acuity of the three younger observers at 1 foot-candle was 1.25. This value could be attained by all the older observers: J. B., aged 42, at 7.5 foot-candles; A. L., aged 63, at 14 foot-candles; D. S., aged 53, at 74 foot-candles, and R. S., aged 70, at 82 foot-candles. From these data it may be inferred that many old eyes may be given the same power to see, as tested by acuity, as is had by young eyes at intensities which were commonly used not many years

ago and which are still used in too large a number of cases, or, if not the same power, a very good one, at least as compared with the conventionally accepted standard of acuity.

Considerable work is still being done under artificial illumination at 5 foot-candles and doubtless some as low as 2.5 foot-candles. That the eyes of a person 63 years of age can be made to have at 60 foot-candles the same order of acuity as the average of those of a group of young persons at 5 foot-candles, and at 27 foot-candles the same as the younger eyes at 2.5 foot-candles is a matter of no little practical importance; and that eyes 70 years old can be given the same acuity even at 100 foot-candles as young eyes at 1 foot-candle is a matter of interest if not of practical importance. Obviously a great deal can be done in eliminating age as a factor in working efficiency by a suitable gradation of the intensity of illumination employed for different age groups. Also a great deal could be done in the interest of economy in lighting if workers were separated, whenever possible, into groups with respect to age. The high intensities of light which are an absolute necessity to middle-aged and old eyes are more or less wasted on young eyes. It is by no means our intention to say, however, that high intensities within reasonable limitations are not of benefit to young eyes, but the age distinction should be clearly recognized. What is of minor benefit in the one case is an extreme need in the other. The money available for lighting in any given situation should, therefore, be distributed accordingly. Lighting practice has been conventionalized too narrowly with respect to the intensity of light. In each case the individual needs should be determined and the intensity given that is required.

5. The curves which we have obtained thus far fall into three types. Whether these types are characteristic we are not as yet prepared to say. The cases studied are too few to warrant definite conclusions on this point. The data presented and other data that we have obtained suggest, however, that there may be three types of eye: (*a*) A type which may be characteristic of youth. The curve for this type shows a high level of acuity throughout and a pronounced knee occurring at 10 foot-candles. (*b*) A type which may be characteristic of middle and early old age. This type shows a low level of acuity at the low and medium intensities, a fairly high level at high intensities and a slope of curve which is more gradual throughout its course. (*c*) A type which may be characteristic of old age. Here there is a low level of acuity throughout and a pronounced knee occurs at from 10 to 20 foot-candles. In the curves shown there is some overlapping as to type. For example, the curve for M. S., aged 25, shows some tendency to conform in shape to the second type and might therefore be classed as a curve for an eye

functionally older than its chronological age; that for D. S., aged 53, conforms in shape to the second type and in level to the third.

Table 4 shows the percentage increase in acuity from 0.5 to 10 foot-candles and from 10 to 100 foot-candles for the three types of curve.

The need of high intensities of illumination by these three types of eye may be analyzed as follows: (*a*) The first type, with its high level of acuity throughout and a pronounced knee of the curve at approximately 10 foot-candles, will not, comparatively speaking, benefit greatly by intensities above this value. (*b*) The second type, which has a low level of acuity at low and medium intensities, a gradual slope of curve and a fairly high acuity at high intensities, benefits greatly by high intensities. In fact, the curve for this type of eye has still a considerable steepness of slope even at 100 foot-candles. In this connection we are continuing the study in order to find out whether there is not some intensity greater than 100 foot-candles at which the curves for young eyes and eyes in the early and middle stages of presbyopia reach the

TABLE 4.—*Percentage Increase in Acuity for the Three Types of Curve*

Increase of Illumination (Foot-Candles)	Type A (Youth)			Type B (Middle and Early Old Age)			Type C (Old Age)
	E.L.	M.E.	M.S.	J.B.	A.L.	D.S.	R.S.
0.5 to 100	77	77	72	82	81	56	67
10 to 100	19	20	24	64	61	59	22

same level. It may be, for example, that young eyes attain the physiologic limit of benefit for increase of intensity at a lower level of intensity than older eyes. (*c*) The third type, with its low level of acuity throughout and its curve rising rapidly up to from 10 to 20 foot-candles and slowly beyond that, needs in general all the light it can get to give it a satisfactory working level of clear seeing. These comments as to the benefit that may be derived from an increase in intensity of light are made, it will be understood, with reference to benefit as measured by the acuity test. What the results are with regard to speed of vision and power to sustain clear seeing is now being determined.

6. The increase in acuity produced by increasing the intensity of light when measured in percentage is in general greater for the old than for the young eyes. For the observers in the early and middle stages of presbyopia, it is much greater; for the observer 70 years of age, it was greater only over certain ranges in the scale. This is shown in table 5.

Curves showing the percentage increase in acuity for the different observers are given in figure 3. In determining these percentages of increase, the value of acuity at 0.5 foot-candles was taken as base.

In later studies connected with the determination of norms for eyes at different ages we hope to obtain data pertaining to the various points considered in this paper on a much larger number of observers. To accumulate these data will require a long time and involve a great deal of difficulty. It is difficult, for example, to get old people to subject themselves to so long a series of experiments as these determinations require. Moreover, the time usually needed for the series is greatly increased by the susceptibility of such observers both to ocular and to bodily fatigue. This is particularly true in the case of the more advanced ages required to fill out the scale at its upper end. Again, it is somewhat difficult to find old eyes that are not suffering from defects besides those which are usually attributed to age, and when found they are apt to be of the kind that had extranormal powers of vision when young. We have, however, we believe, carried the study far enough at this time to give a significant indication of what may be expected in a more comprehensive survey. Without question, age is a most important factor

TABLE 5.—*Percentage Increase in Acuity*

Increase in Intensity (Foot-Candles)	Younger Group				Older Group				
	E.L.	M.E.	M.S.	Average	J.B	A.L.	D.S.	R.S.	Average
0.5 to 100	111	113	113	112	199	190	149	103	162
5 to 100	26	36	33	31	90	87	76	39	74
10 to 100	19	20	25	21	64	61	59	22	52

in the effect of intensity of light on clear seeing, and the grading of intensity to meet the age requirement is an important if not the major problem in the use of intensity in lighting practice.

SUMMARY

There is great need for a more intelligent use of intensity of light. In this connection an important factor to be considered is the age requirement.

Determinations of visual acuity have been made on a group of presbyopic and nonpresbyopic eyes at intensities of light ranging from 0.5 to 100 foot-candles. The light used was corrected for color by means of daylight glass.

Data are given on the following points: (1) the effect of increase in intensity of light on acuity over the aforementioned range of intensities, (2) age as a factor in this effect, (3) equivalent intensities of light for young and for old eyes, i. e., intensities which give the same acuity for these eyes and (4) the presence of effects of an increase in intensity on acuity which may not be due entirely to age.

Various benefits derived from the data are noted and discussed, such as (1) the acquisition of a better knowledge of how much can

be expected of an increase in intensity in the mitigation of the effect of advancing age on the powers of vision; (2) the demonstration of a need, in the interests of lighting economy, of dividing workers into groups with respect to age, wherever possible, and grading the intensity of the light provided accordingly, and of giving due attention to the age requirement in all lighting situations (the use of intensity having been conventionalized much too narrowly in lighting practice), and (3) the demonstration, on the medical side, of the importance of adding the determination of acuity at suitably different intensities of light to the routine examination of presbyopic eyes and of including information on this point in the prescription given to the patient. Such information would be of great service both to the patient and to the merchandiser of light.

Results of similar studies on both the static and the dynamic speed of vision are promised in later papers; also the description of a portable device for determining the amount of light that is needed for different types of work and for eyes at different ages.

CHOLESTEROL CONTENT OF CATARACTOUS HUMAN LENSES

P. W. SALIT, PH.D.

AND

C. S. O'BRIEN, M.D.

IOWA CITY

The cholesterol content of normal and cataractous crystalline lenses is an old and unsettled question. Most of the early work was fragmentary and qualitative. This paper includes a discussion of the literature and a report of data from analyses of more than one hundred cataractous lenses which, before removal, were studied with the slit-lamp microscope, then extracted by the intracapsular method and carefully analyzed.

Von Graefe,[1] in 1854, was the first to see and recognize cholesterol in the lens. In 1857, Mettenheimer[2] reported having seen double refractive substances, which he regarded as myelin, in cataractous lenses and also in the normal lens of a 28 year old woman. From one comparatively clear lens he succeeded in isolating myelin and cholesterol by boiling in alcohol. Eleven years later, Kühne[3] reported the finding of fat and cholesterol in the normal lenses of oxen, with greater quantities in the lenses of older animals. Tweedy[4] described a case of incipient cataract in which there were large deposits of golden cholesterol scales. Laptschinsky,[5] in 1876, found great variations in the cholesterol content (0.06 to 0.49 per cent) of individual ox lenses but made no mention of age. Knies[6] examined one hundred and fifty human cataractous lenses, removed by the extracapsular method, which he had kept for some time in alcohol, but found no cholesterol. On the other

From the Department of Ophthalmology, State University of Iowa.

1. von Graefe, A.: Seltene Fälle von Cataract, Arch. f. Ophth. **1**:323, 1854.

2. Mettenheimer: Cor.-Bl. d. Ver. f. gemeinsch. Arb. z. Förd. d. wissensch. Heilk., 1857, no. 24, p. 331; 1858, no. 31, p. 467; cited by Kranz.[23]

3. Kühne, W.: Lehrbuch der physiologischen Chemie, Leipzig, W. Engelmann, 1868, p. 104.

4. Tweedy, J.: Cholesterin in the Eye, Lancet **2**:519, 1873.

5. Laptschinsky, M.: Ein Beitrag zur Chemie des Linsengewebes, Arch. f. d. ges. Physiol. **13**:631, 1876.

6. Knies, M.: Zur Chemie der Altersveränderungen der Linse, Untersuch. a. d. physiol. Inst. d. Univ. Heidelberg **1**:114, 1877; abstr., Klin. Monatsbl. f. Augenh. **15**:332, 1877.

hand, Zehender, Matthiessen and Jacobsen,[7] who studied whole normal and cataractous human lenses, extracted by the intracapsular method, reported only a trace of cholesterol in the former but large amounts in cataractous lenses. They pointed out, in their comment on Knies' findings,[6] that the alcohol used as a preservative must have been responsible for the absence of cholesterol. In a later publication these authors submitted a radically different report on whole normal lenses; they were found to contain almost as much (2.24 per cent) cholesterol as the amount (2.71 per cent, dry weight) in the cataractous lenses. In the first experiment normal lenses were obtained from a 26 year old woman and a 14 day old child, whereas in the second experiment there were ninety-one normal lenses, twenty-seven from subjects over 60 years of age and sixty-four from subjects under 60 years. There were eighty-six cataractous lenses from persons over the age of 60 and sixty-two from those under the age of 60. In each group there was approximately the same number of lenses from persons under the age of 60, but in the cataractous group, as compared with the normal group, there were more than three times as many from persons over the age of 60. Since lenses from persons over the age of 60 (table 2) contain more cholesterol than those from persons under this age, the slight difference between the cholesterol contents of the two groups may be accounted for on this basis, and there is no reason to assume that cataractous lenses contain more cholesterol than do normal lenses. According to the same authors, the cholesterol content of the nucleus was found to be 2.2 per cent and that of the cortex 0.75 per cent.

Cahn,[8] in 1881, reported the cholesterol content of cataractous lenses to be greater than that of normal lenses, the former ranging from 4.55 to 6.22 per cent, dry weight, and the latter averaging only 0.62 per cent. Cahn, however like Laptschinsky, evidently paid no attention to age or to the method of extraction, and therefore his figures are not of importance in a comparative study. Furthermore, the lenses were not analyzed immediately but were collected and preserved for some time in alcohol. Five years later, Michel and Wagner[9] reviewed the literature on the chemistry of the eye and submitted their own experimental data on the lipids of normal ox lenses, which fully corroborated the findings of Kühne; all the lenses contained some fat and cholesterol, the content of the latter being slightly higher in old animals. They,

7. Zehender, W.; Matthiessen, L., and Jacobsen, O.: Ueber die Brechungscoefficienten und die chemische Beschaffenheit kataraktöser Linsensubstanz, Klin. Monatsbl. f. Augenh. **15**:311, 1877; **17**:307, 1879.

8. Cahn, A.: Zur physiologischen und pathologischen Chemie des Auges, Ztschr. f. physiol. Chem. **5**:213, 1881.

9. Michel and Wagner: Chemische Untersuchungen des Auges, Arch. f. Ophth. **32**:155, 1886.

like Cahn, preserved the lenses in alcohol, but no further details of the method were published. In 1895, Lang [10] found numerous cholesterol crystals in the cataractous lenses of a 60 year old man. Soon afterward Krautschneider [11] observed similar crystals in the clear lens of a 59 year old man. Gross,[12] in 1907, carried out quantitative analyses on two groups of cataractous lenses removed by the extracapsular method; he obtained an average of 0.48 per cent cholesterol, on the basis of dry weight. This is a rather low figure for extracapsular lenses as compared with the value (2.2 per cent) which Zehender, Matthiessen and Jacobsen obtained for the nucleus. It is probable that, as Goldschmidt [13] pointed out, part of the cholesterol was destroyed by the drying process which was carried out at 110 C. The same procedure was employed by Gross in analyses of the lenses of calves and aged cattle; the average cholesterol values were 0.24 per cent for calves and 0.29 per cent for old animals. Gross argued against an increase of cholesterol in cataractous lenses as compared with normal lenses, but the arguments carry little weight because of the loss of cholesterol due to drying, as pointed out by Goldschmidt and later demonstrated experimentally by Leinfelder and one of us (Salit).[14] Jess,[15] likewise working with normal and cataractous ox lenses, dried them at approximately the same temperature (105 C.) previous to extraction of the cholesterol. However, since Jess carried out analyses on both cataractous and normal lenses of similar animals at the same time, his results merit consideration. He found the test for cholesterol negative with normal lenses of oxen between the ages of 3 weeks and 2 years, positive with the lenses of animals between the ages of 3 and 10 years and strongly positive with those of animals between the ages of 12 and 18 years. In eight lenses containing senile cataracts from oxen between the ages of 6 and 18 years, the amounts of fat, cholesterol and lecithin were only slightly higher than in normal lenses, the minimum and maximum values being 0.3 and 0.48 per cent total lipids, with an average of 0.37 per cent. Although Jess' data are not entirely free from criticism as a basis for his argument that the cholesterol content of cataractous lenses is in no wise different from that of normal lenses, they indicate that the cholesterol

10. Lang, W.: Cholesterin Crystals in the Lens, Tr. Ophth. Soc. U. Kingdom **15**:117, 1895.

11. Krautschneider: Ein Fall von Krystallbildung in der Linse, Beitr. z. Augenh. **26**:34, 1897; cited by Kranz.[23]

12. Gross, O.: Beiträge zur Linsenchemie, Arch. f. Augenh. **57**:107, 1907.

13. Goldschmidt, M.: Die Lipoide der Linse, Biochem. Ztschr. **127**:210, 1922.

14. Leinfelder, P. J., and Salit, P. W.: Unpublished data; The Lipids of Retina, Brain and Blood, Am. J. Ophth. **17**:619, 1934.

15. Jess, A.: Beiträge zur Kenntnis der Chemie der normalen und der pathologischveränderten Linse des Auges, Ztschr. f. Biol. **61**:93, 1913.

content runs more or less parallel with age. This fact was also brought out by the experiments of Goldschmidt on human lenses, but with the values reversed for ages within the limits of infancy and the second decade of life. Thus Goldschmidt found the highest value, 1.71 per cent dry weight, in the first year of life; it then gradually decreased to 0.52 per cent at the end of the twentieth year; after this age there was again a steady rise to 1.3 per cent in the eighth decade. It must be pointed out, however, that Goldschmidt, after concentrating the lipid extracts on a water bath, evaporated the remainder in a vacuum and then dried the residue to constant weight in a desiccator in the dark. This process of evaporation and drying must have extended over long periods and must have somewhat changed the chemical nature of the cholesterol, e. g., by oxidation, decomposition or other means. It was found by Leinfelder and one of us (Salit [14]) that the cholesterol content of tissue extracts diminished at varying rates on prolonged exposure to air, even if the drying was carried out in the dark and in an evacuated desiccator. One of us (Salit [16]), in 1931, working on human cataracts, extracted the lenses with an alcohol-ether mixture immediately after removal from the eyes and then determined the cholesterol content by a slight modification of the colorimetric methods of Authenrieth and Funk [17] and Bloor; [18] the cholesterol values of twenty-six unclassified cataracts, removed by either the extracapsular or the intracapsular method, varied between 0.23 and 0.89 per cent, wet weight, with an average of 0.61 per cent. In the same report he stated that a normal lens from a 2 year old child contained 0.182 per cent cholesterol, that from a young adult 0.174 per cent, and that from a middle aged man 0.275 per cent. In agreement with the findings of Zehender, Matthiessen and Jacobsen on lenses of infants as well as those of Jess on lenses of oxen of varying ages, Bürger and Schlomka [19] found only traces of cholesterol in the lenses of new-born calves. However, there was a gradual increase up to 222 mg. per hundred grams, wet weight, or 610 mg. per hundred grams, dry weight, in 15 year old animals. Their

16. Salit, P. W.: Chemical Studies of Lipids of Normal Animal Lenses, Cataractous Human Lenses and the Blood of Patients with Cataract, Arch. Ophth. **5**:354 (March) 1931.

17. Authenrieth, W., and Funk, A.: Ueber kolorimetrische Bestimmungsmethoden: Die Bestimmung des Gesamtcholesterins im Blut und in Organen, München. med. Wchnschr. **60**:1243, 1913.

18. Bloor, W. R.: Studies on Blood Fat: II. Fat Absorption and the Blood Lipoids, J. Biol. Chem. **23**:317, 1915; The Determination of Small Amounts of Lipid in Blood Plasma, ibid. **77**:53, 1928.

19. Bürger, M., and Schlomka, G.: Beiträge zur physiologischen Chemie des Alterns der Gewebe: I. Untersuchung am menschlichen Rippenknorpel, Ztschr. f. d. ges. exper. Med. **55**:287, 1927; Untersuchungen an der Rinderlinse, ibid. **58**:710, 1928.

drying process appears more free from criticism than those of other investigators. The lenses were first broken into small fragments and then dried in a specially prepared tube at 60 C. over anhydrous phosphoric acid in a vacuum. The final drying was carried out at 100 C. in a similar apparatus. The cholesterol was estimated gravimetrically by the digitonin method. One of us (Salit [16]) determined the cholesterol content of normal lenses from 5 week old calves and 2 year old oxen and found the respective averages to be 50.1 and 43.1 mg. per hundred grams, wet weight. These values, however, are subject to the same criticism as those of Gross and Jess, for the lenses were likewise dried, previous to cholesterol extraction, at a temperature of approximately 100 C.

In more recent publications it has been mentioned that inconsistent results on cataractous lenses may have been partly due to the preponderance of one or another type of cataract; e. g., Burdon-Cooper [20] made the statement, on the basis of his experiments, that cholesterol occurs in greater quantities in diabetic cataractous lenses. Magnasco [21] found the average cholesterol content in nine senile cataractous lenses to be 2.16 per cent, dry weight, a value nearly the same as that obtained by Adams [22] on similar lenses (2.579 per cent, dry weight). Certain other types of cataract observed in Magnasco's experiments gave much higher values; e. g., the content of five lenses with black cataracts averaged 5.58 per cent, and that of three cataractous lenses presenting visible cholesterol crystals averaged 6.86 per cent. Kranz [23] observed, with the polarization microscope, myelin-like, doubly refractive substances and occasional cholesterol crystals in lenses with senile cataracts as well as in those with traumatic cataracts caused by gross physical injury; however, such substances were absent in lenses with traumatic cataracts caused by perforation or with swollen lamellar cataracts and in normal lenses. Neuschüler [24] found increased cholesterol but no fat in a lens with a black cataract; the blood cholesterol was likewise increased, reaching a value of 0.223 per cent. According to Cahane,[25] the cholesterol increased from 0.102 per cent in calves from 1½ to 5 months old to 0.121 per cent in oxen from 3 to 5 years old. He observed also a higher cholesterol content in the lenses of dogs with tetany. Human

20. Burdon-Cooper, J.: Etiology of Cataract, Brit. J. Ophth. **6**:387, 1922.

21. Magnasco, M.: Ricerche sul tasso della colesterina nel cristallino cattarattoso, Saggi di oftal. **4**:358, 1929.

22. Adams, D. R.: The Rôle of Calcium in Senile Cataract, Biochem. J. **23**: 902, 1929.

23. Kranz, H. W.: Die polarisationsmicroskopische Untersuchung der kataraktös getrübten Linse, Arch. f. Ophth. **118**:571, 1927.

24. Neuschüler, I.: Della cataratta nigra, Letura oftal. **7**:237, 1930.

25. Cahane, M.: Recherches sur la teneur du cristallin en eau et en cholestérol suivant l'âge. Cataracte et cholestérol, Compt. rend Soc. de biol. **108**:992, 1931.

cataractous lenses, however, showed still higher values, from 0.6 to 0.64 per cent (apparently on the basis of wet weight). An increase of cholesterol in the lenses of thyroparathyroidectomized dogs was observed also by Parhon and Werner;[26] while the cholesterol values of the lenses of normal dogs varied between 0.2 and 0.312 per cent, those of thyroparathyroidectomized animals varied between 0.25 and 0.386 per cent (apparently on the basis of wet weight). Updegraff,[27] who determined the cholesterol content of thirty-seven cataractous and five normal lenses, found no correlation between the cholesterol content and the age, sex or clinical findings.

It is generally believed that cholesterol and lipids are increased in cataractous lenses, and certain theories have been suggested as to the rôle that cholesterol may play in the production of cataract. Toufesco,[28] who identified myelin-like substances in cataractous lenses, believed there was fatty degeneration of the lens fibers as a result of senile changes in the lens protein. Leber,[29] after a survey of all investigations previous to 1906, assumed an increase of lipids in cataractous lenses and believed that cataract was due to fat-soluble toxins. He demonstrated, by experiments, that such substances as chloroform, phenol, aniline, β-hydroxybutyric acid, aceto-acetic acid, acetone, etc., are easily absorbed by the lens, and he postulated that they gradually bring about degeneration of the lens tissue. Michail, Cadarin and Vancea,[30] on the basis of experiments in vitro, suggested that senile cataracts may be the result of a strong cholesterogenic property of certain lenses. They stated that cholesterol may increase or decrease in tissues on exposure to the air, the amount depending on the nature of the tissue and the time of exposure; lenses were found to be cholesterogenic during the first two hours of exposure, but thereafter cholesterolytic; decapsulated lenses were slightly more cholesterogenic. Berezinskaya,[31] who found cholesterol and cystine crystals in a lens of a 42 year old man, with an apparently hereditary type of cataract, assumed that they were formed

26. Parhon, C. I., and Werner, G.: Teneur en eau, cholestérol, calcium et potassium de la peau, cholestérol du crystallin et calcium de l'humeure aqueuse, chez les animaux thyroparathyroidectomisés, Compt. rend. Soc. de biol. **109**:989, 1931.

27. Updegraff, H.: Calcium, Phosphorus and Cholesterol in Cataractous vs. Apparently Normal Lenses from Human Eyes, Proc. Soc. Exper. Biol. & Med. **29**:964, 1932.

28. Toufesco, S.: Sur le cristallin pathologique, Ann. d'ocul. **1**:136, 1906.

29. Leber, A. T.: Zum Stoffwechsel der Krystall-linse, Arch. f. Ophth. **62**:85, 1906.

30. Michail, D.; Cadarin, I., and Vancea, P.: Recherches in vitro sur le rôle du crystallin dans le métabolism de la cholestérine, Compt. rend. Soc. de biol. **94**:154, 1926.

31. Berezinskaya, D.: Cholesterin und Cystin in der Linse, Russk. oftal. J. **6**:549, 1927; abstr., Zentralbl. f. d. ges. Ophth. **18**:785, 1927.

by abnormal decomposition of protein. Michail and Vancea [32] produced experimentally, by naphthalene intoxication, a temporary increase of cholesterol in most of the organs of rabbits; in the lens, retina and heart the maximum increase was followed by an immediate decrease, whereas in other organs, such as the capsules of the suprarenals, the spleen, the digestive organs and the brain, the decrease came on gradually. They therefore regarded the retina and the lens as principals in the cholesterol metabolism of the eye. Furthermore, they believed that a sudden disappearance of cholesterol from the lens brings about cataract but that when the cataract has sufficiently progressed cholesterol begins to accumulate.

From the foregoing survey of the literature certain conclusions may be drawn: (1) Approximately one third of the work on the cholesterol content of lenses is qualitative only; (2) the results of approximately half of the quantitative work, owing to defective methods, have likewise only a qualitative value; (3) the remaining half of the quantitative work, with more or less accurate determinations, is somewhat invalidated by omission of consideration of the age factor; (4) no serious attempt has been made to determine a definite relationship between the amount of cholesterol and the stage of development of the cataract, and (5) in some cases no attention was paid to the method of cataract extraction, i. e., whether the extracapsular or the intracapsular method was used. In extracapsular extraction only the nucleus is removed intact, whereas by intracapsular extraction the entire lens is obtained. The significance of this point is apparent from the work of Zehender, Matthiessen and Jacobsen, who found approximately three times as much cholesterol in the nucleus as in the cortex, i. e., 2.2 and 0.75 per cent, dry weight, respectively.

EXPERIMENTAL TECHNIC

Determinations of cholesterol were made on one hundred and four cataractous lenses and on normal lenses from a 16 year old girl and an 86 year old man. The age of each patient was noted, and the approximate duration of visual deterioration and changes in the lens were estimated from the history. Each cataract was studied with the slit-lamp microscope and classified, according to stage, as incipient, intumescent or mature. Each lens was extracted by the intracapsular method, weighed immediately and then, by means of a porcelain spatula, spread over a piece of filter paper. The filter paper was rolled so that the lens paste lay between two surfaces, thus assuring rapid evaporation of moisture and direct contact of practically every part of the lens with the extracting medium. The filter paper containing the lens paste was placed in a 50 cc. Erlenmeyer flask, covered with 5 cc. of chloroform and allowed to stand in the dark for from one to three days. The lens material was then broken up into small fragments by

32. Michail, D., and Vancea, P.: Der Cholesterinstoffwechsel in den Organen bei der Naphthalinvergiftung, Cluj. med. **10**:81, 1929; abstr., Zentralbl. f. d. ges. Ophth. **21**:770, 1929.

means of a glass rod, and the extract was decanted onto a filter and filtered into a large test tube. The residue was macerated in 3 cc. of a 1:3 ether-alcohol mixture, and the second extract was filtered into the same test tube. Three such ether-alcohol extractions were found to be sufficient. The combined extracts were evaporated just to the point of dryness on a water bath, at approximately 90 C. Estimations of the absolute and relative amounts of cholesterol in the residue were made by a slightly modified procedure of the colorimetric methods of Authenrieth and Funk and of Bloor.

TABLE 1.—*Minimum, Maximum and Average Cholesterol Values of Cataractous Lenses in Various Stages of Development*

Stage	No. of Lenses	Age of Patient	Duration, Years	Weight, Gm.	Mg. of Cholesterol per Lens	Mg. of Cholesterol per 100 Gm.
Incipient	57	29-85	0.25-10.0	0.1190-0.2805	0.557-2.322	273-900
Averages	..	67.1	1.7	0.2090	1.0964	510.2
Intumescent	15	44-80	0.1-6.0	0.1422-0.3110	0.482-1.380	327-831
Averages	..	65.5	2.7	0.2081	0.9830	465.6
Mature	32	50-83	0.7-10.0	0.1295-0.2925	0.770-2.469	239-679
Averages	..	68.0	3.7	0.2012	1.0530	512.8

TABLE 2.—*Minimum, Maximum and Average Cholesterol Values of Cataractous Lenses from Patients of Various Ages*

Age, Decade	No. of Lenses	Age of Patient	Duration, Years	Weight, Gm.	Mg. of Cholesterol per Lens	Mg. of Cholesterol per 100 Gm.
III	1	29	1.5	0.1392	0.557	400.0
V	5	45-48	1.0-3.0	0.1503-0.1918	0.949-1.200	321-635
Averages	..	46.0	1.5	0.1747	0.899	509.0
VI	16	53-59	0.1-7.0	0.1426-0.2818	0.506-1.210	327-570
Averages	..	57.0	2.0	0.2096	0.899	455.3
VII	28	60-69	0.25-10.0	0.1295-0.2734	0.691-2.322	273-736
Averages	..	65.2	2.3	0.1961	1.044	514.0
VIII	44	70-79	0.25-10.0	0.1190-0.3110	0.784-2.469	360-900
Averages	..	74.2	3.7	0.2178	1.131	512.0
IX	9	80-85	0.5-10.0	0.1898-0.2925	0.700-1.783	239-700
Averages	..	82.0	2.9	0.2402	1.198	510.0

RESULTS

In table 1 the results are summarized in terms of minimum, maximum and average cholesterol values as found in the three groups of cataractous lenses. In table 2, the results, also in terms of minimum, maximum and average values, are arranged according to age in decades.

From these data no difference is apparent between the cholesterol content of lenses with incipient cataracts and that of those with mature cataracts. In lenses with intumescent cataracts the content is slightly lower, both in absolute and in relative amounts, but, considering the comparatively small number of lenses in this group, it is probable that the majority accidentally fell within the group showing lower cholesterol

values. This is quite possible, as may be seen from the wide variations in cholesterol content in each of the three groups. Nothing was found in the histories or clinical findings to account for these individual variations in the amounts of cholesterol. Differences in age within the limits of 45 and 85 years do not furnish a solution, the average cholesterol values (table 2) being practically constant within this range. Approximately half of the lenses in the incipient group were in the earliest stages of opacification, but otherwise they resembled normal lenses. If there were any relationship between cataract formation and the choles-

TABLE 3.—*General Summary of Results on the Cholesterol Values of Normal and Cataractous Animal Lenses*

Authors	Source of Material	Type of Lens	Percentage of Cholesterol: Wet Weight	Percentage of Cholesterol: Dry Weight	Age	Comment
Laptschinsky	Oxen	Normal	0.06-0.49 Average 0.22	0.17-1.40* 0.628*	?	
Gross.....	Calves	Normal	0.086*	0.24	?	Lenses dried at 110 C.
	Cows	Normal	0.101*	0.29	Above 13 yrs.	
Jess.....	Oxen	Normal	.....	Negative	3 wks.-2 yrs.	Lenses dried at 105 C.
	Oxen	Normal	.....	Positive	3-10 yrs.	Total lipids of cataractous lenses, from 0.3 to 0.48%; average, 0.37%
	Oxen	Normal	.....	Strongly positive	12-18 yrs.	
	Oxen	Cataractous	.....	Strongly positive	6-18 yrs.	
Bürger and Schlomka	Calves	Normal	0.056	0.134	1 day-1 yr.	Lenses first dried in vacuum at 60 C., then for a shorter time at 100 C.
	Oxen	Normal	0.222	0.610	14-17 yrs.	
Salit.....	Calves	Normal	0.0501	0.143*	5 wks.	Lenses dried at about 100 C.; extracted with ether and alcohol
	Oxen	Normal	0.0431	0.123*	2 yrs.	
Cahane.....	Oxen	Normal	0.102	0.291*	1.5-5 mos.	
	Oxen	Normal	0.121	0.346*	3-5 yrs.	
Parhon and Werner	Dogs	Normal	0.20-0.312	0.57-0.89*	?	
	Dogs	Thyroparathyroidectomized	0.25-0.386	0.71-110*	?	

* Supplementary figures calculated from the original values.

terol content of the lens, one would expect less cholesterol in lenses with incipient cataracts and more in lenses with mature cataracts.

The cholesterol contents of the two normal lenses, one from a 16 year old girl and the other from an 86 year old man, were found to be 254 and 500 mg. per hundred grams, respectively. The latter figure is approximately the same as the average for all cataractous lenses in patients between the ages of 45 and 85 years. It appears that cataractous lenses do not differ from normal lenses in cholesterol content.

A decrease in the weight of cataractous lenses has been noted by several investigators, the decrease being proportional to the stage of development.[33] This finding is corroborated (table 1), the average

33. Salit, P. W.: Calcium Content and Weight of Human Cataractous Lenses, Arch. Ophth. **9**:571 (April) 1933.

weight for lenses containing incipient, intumescent and mature cataracts being 0.2090, 0.2081 and 0.2012 Gm., respectively, per hundred grams. The respective average durations of the three stages (table 1) are likewise in agreement with those published by one of us (Salit [33]). In this

TABLE 4.—*General Summary of Results on the Cholesterol Values of Normal and Cataractous Human Lenses*

Authors	Type of Lens	Percentage of Cholesterol		Age	Comment
		Wet Weight	Dry Weight		
Zehender et al.	Normal	0.784*	2.24	Within range for usual senile type	Intracapsular; cholesterol estimated by polarization
	Cataractous	0.949*	2.71		
	Cataractous, nucleus	0.77*	2.2		
	Cataractous, cortex	0.263*	0.75		
Cahn.....	Normal	0.217*	0.62	?	
	Cataractous	1.59-2.18*	4.55-6.22	?	
Gross.....	Cataractous	0.168*	0.48	?	Extracapsular; lenses dried at 110 C.
Goldschmidt..	Normal	0.599*	1.71	0-1 yr.	Lenses extracted with petroleum, ether, acetone and benzene; concentrated on water bath; residue dried in vacuum and desiccator
	Normal	0.182*	0.52	20 yrs.	
	Normal	0.462*	1.32	70-80 yrs.	
Salit.....	Normal	0.180	0.514*	2 yrs.	Lenses extracted with ether and alcohol immediately after removal from eyes; intracapsular and extracapsular
	Normal	0.174	0.500*	Young adult	
	Normal	0.275	0.786*	Middle aged	
	Cataractous	0.23-0.89	0.66-2.54*	37-79 yrs.	
	Average	0.61	1.743*		
Magnasco.....	Ordinary senile cataract	0.756*	2.16	?	
	Dark cataract	1.953*	5.58	?	
	Visible cholesterol crystals	2.401*	6.86	?	
Adams.....	Ordinary senile cataract	0.903*	2.58	?	
Cahane.....	Cataractous	0.6-0.64	1.71-1.83*	?	
Updegraff.....	Cataractous and normal	0.28-0.72	0.81-2.05* Aver. 1.430	?	Lenses extracted with hot alcohol
Salit.....	Cataractous				
	Incipient	0.273-0.900	0.780-2.571*	29-85 yrs.	Intracapsular; lenses first extracted with chloroform, then with ether and alcohol immediately after removal from eyes
	Average	0.510	1.457*	67.1	
	Intumescent	0.327-0.831	0.934-2.374*	44-80 yrs.	
	Average	0.466	1.331*	65.5	
	Mature	0.239-0.679	0.683-1.940*	50-83 yrs.	
	Average	0.513	1.466*	68.0	
	Normal	0.254	0.726*	16 yrs.	
	Normal	0.500	1.429*	86 yrs.	

* Supplementary figures calculated from the original values.

publication the respective values are given as 2.2, 3.1 and 4.3 years as compared with 1.7, 2.7 and 3.7 years found in the present study.

It has been pointed out by other investigators that the normal lens increases in size and weight throughout life. Data in table 2 bring out the fact that cataractous lenses also are heavier in older patients; there is a steady increase in weight from 0.1392 Gm. at the age of 29 to

0.2402 Gm. at the ages from 80 to 85, although these lenses are lighter than normal lenses in patients of similar ages.

In tables 3 and 4 a summary is given of the cholesterol values of animal and human lenses, normal and cataractous, as determined in quantitative analyses by various investigators. In the literature some cholesterol values are given in terms of wet weight and others in terms of dry weight. In order to compare the values, those in tables 3 and 4 are given on the basis of both wet and dry weight, the supplementing figures, marked with asterisks, having been calculated from the original values. In this calculation the solids of the lens substance were assumed to constitute 35 per cent of the wet weight.

SUMMARY

An analysis of the literature on the cholesterol content of normal and cataractous crystalline lenses is presented. Most of the data on this problem have been of qualitative nature only. The preponderance of opinion has been that cataractous lenses contain more cholesterol than normal lenses and that the cholesterol increases as the cataract advances. In the present study of one hundred and four lenses with cataracts in various stages of development, more or less the same variations in the cholesterol content were found in all stages; fifty-seven lenses with incipient cataracts giving an average of 510.2 mg. of cholesterol per hundred grams, fifteen with intumescent cataracts, an average of 465.6 mg., and thirty-two with mature cataracts, an average of 512 mg. From this it is concluded that cataractous lenses, as a group, do not differ in their cholesterol content from normal lenses of persons of similar age. Furthermore, the contention of several investigators that the cholesterol content increases with age is here corroborated by the results obtained on two normal human lenses, the lenses from a 16 year old girl giving a value of 254 mg. per hundred grams and that of an 86 year old man, 500 mg. The latter figure is approximately the same as the average for cataractous lenses in patients from 45 to 85 years of age.

NYSTAGMUS IN INFANTS

REPORT OF A CASE OF MONOCULAR HORIZONTAL TYPE

PHILIP J. MOORAD, M.D.
CANANDAIGUA, N. Y.

Monocular nystagmus in an infant, without any known associated pathologic state, is of sufficient rarity to warrant reporting. The report is particularly justifiable since the study of the case has led to the belief that nystagmus in children is caused by the same fundamental set of conditions as that in miners and that produced experimentally in young dogs, that is, by living for a long period in poor and inadequate light. Furthermore, the immediate beneficial response of the nystagmus in this case to the use of homatropine may lead to further trial and study of this drug as a therapeutic agent in the treatment of nystagmus in children.

A review of the literature shows that unilateral nystagmus without any demonstrable pathologic condition producing it or associated with it is very rare. That of horizontal type is remarkably rare. Peter [1] stated that monocular nystagmus "as a rule" is of vertical type; that the horizontal variety is an exception. In bilateral nystagmus, however, the two types occur with about equal frequency. In 1906 Duane (quoted by Post [2]) published a report of fifty-two cases due to various causes. Of these, only eleven were of horizontal type; the others were vertical, rotatory or mixed.

Generally, nystagmus is a sign that may appear in protean pathologic conditions which in their morbid anatomy are varied and distinctly different. In some of these diseases, nystagmus is of great diagnostic importance; in others, it is a rare finding and has no diagnostic value; and in still others, it is a casual finding that has no relationship to the coexisting pathologic state. Congenital nystagmus, as the nystagmus of infants is ordinarily called, is of the latter group. Opinions are many and conflicting as to the cause, morbid anatomy and pathologic physiology of this type of nystagmus.

Monocular nystagmus has been seen in many diseases of the central nervous system: in apoplexy involving the parietal, temporal and occipital lobes; [3] in diseases of the cerebellum, corpus striatum and

1. Peter, Luther C.: The Extra-Ocular Muscles: A Clinical Study of Normal and Abnormal Motility, Philadelphia, Lea & Febiger, 1927, p. 283.

2. Post, Lawrence: Unilateral Nystagmus, Am. J. Ophth. **8**:632 (Aug.) 1925.

3. Yawger, N. S.: Familial Head-Nystagmus in Four Generations Associated with Ocular Nystagmus, J. A. M. A. **69**:773 (Sept. 8) 1917.

cerebral cortex;[4] in congenital syphilis;[5] in epidemic meningitis and in injury to the supranuclear pathways;[6] in lesions of the pons, anterior quadrigeminal bodies, optic thalami and cerebellar peduncles; in Friedreich's disease, multiple sclerosis, spastic paraplegia, ataxic paraplegia, progressive muscular atrophy and syringomyelia;[1] in trauma to the head and in syphilis of the central nervous system;[7] in mongolian idiocy[8] and epidemic encephalitis,[9] and in the diseases of the nerves of the eye.[10] The condition is more rarely seen in hysteria[11] and in mental deficiency.[10] The relationship between these different diseases and the occurrence of monocular nystagmus is variously explained, and no identical morbid anatomy is given.

In cases of monocular nystagmus in which no disease of the nervous system could be demonstrated, refractive errors or other visual difficulties were considered as causative factors. The difficulties held to be responsible for the nystagmus were in the form of astigmatism,[12] amblyopia,[13] hypermetropia,[14] weakness of the extra-ocular muscles of the eye,[15] opacities of the cornea[1] and of the media,[2] presbyopia[16] and strabismus.[17] In conditions of this sort, more than in the group of nervous diseases mentioned, nystagmus (usually of the bilateral type) is seen with sufficient frequency to lead to the belief among ophthalmologists that an association exists. This belief is confirmed with finding, in the majority of the cases of nystagmus, either some refractive error or some abnormality that interferes with clear vision. Such difficulties undoubtedly play an important rôle in predisposing the patient

4. Sorsby, Arnold: Latent Nystagmus, Brit. J. Ophth. **15**:1 (Jan.) 1931.

5. Asherson, N.: Spontaneous Nystagmus in Congenital Syphilis, Arch. Dis. Childhood **5**:331 (Oct.) 1930.

6. Arkin, W., and Sterling, W.: Le nystagmus monoculaire, Arch. d'opht. **43**:77 (Feb.) 1926.

7. Rabinowitsch, M.: Ueber den Nystagmus monocularis, Ztschr. f. Augenh. **65**:162 (June) 1928.

8. Herrman, Charles: Head Shaking with Nystagmus in Infants, Am. J. Dis. Child. **16**:180 (Sept.) 1918.

9. Moore, Robert Foster: Medical Ophthalmology, ed. 2, Philadelphia, P. Blakiston's Son & Company, 1925.

10. Miller, G. Macleod, and Wilson, James A.: Nystagmus in an Infant, Brit. M. J. **1**:14 (Jan. 1) 1927.

11. Lebensohn, James E.: Nystagmus of Ocular Origin, Arch. Ophth. **5**:638 (April) 1931.

12. Thomas, Roy: Two Cases of Spontaneous Cure of Congenital Nystagmus, Brit. M. J. **1**:825 (May 13) 1933. Peter.[1]

13. Peter.[1] Post.[2] Arkin and Sterling.[6] Rabinowitsch.[7] Lebensohn.[11]

14. Arkin and Sterling.[6] Thomas.[12]

15. Peter.[1] Lebensohn.[11]

16. Evans, T. Stenner: Congenital Nystagmus, Brit. M. J. **1**:453 (March 7) 1925.

17. Post.[2] Arkin and Sterling.[6] Rabinowitsch.[7]

to the development of nystagmus under the proper setting, but it is seriously questioned that they in themselves produce nystagmus.

In a smaller group of cases, in which no diseases of the nervous system and no ocular abnormality could be found, the coexisting disease or abnormality was considered as a causative factor. Such an association, unless on a toxic basis, is difficult to understand when such unrelated conditions as irritability during teething,[18] head colds, bronchitis, pneumonia, gastro-intestinal upsets and infections of the upper respiratory tract,[8] coryza and otitis media,[2] quinsy and infectious diseases [6] and rickets [19] are considered to be responsible for the nystagmus. The relative rarity of nystagmus and yet the frequent occurrence of these diseases in infants of all ages speak against any such association as a cause. The correct explanation for the part played by such illnesses is that the nystagmus probably was present already in a latent form, and that it became "manifested through accident, acute illness or nervousness" (Roche [20]).

Since there was no satisfactory explanation for the nystagmus in infants, and because spasmus nutans (head-nodding, nodding spasm, head nystagmus, etc.) was commonly seen with nystagmus, it was considered as a cause.[21] That head-nodding plays no such rôle is apparent from observation of many cases of spasmus nutans without nystagmus, cases of nystagmus without head-nodding preceding, accompanying or following the eye-twitching, and cases in which head nodding followed by several months a well established nystagmus, as in experimental dogs. Even though both conditions occur in the first year of life and among poor persons living in dim light and similarly disposed, the relationship of cause and effect is questionable. It seems logical to suggest that head-nodding and nystagmus are caused by the same factors, that they are different stages of response of the organism, and that either of them may appear independent of the other or in different order.

REPORT OF CASE

History.—V. T., a girl, 6 months old, was brought to the hospital on Jan. 4, 1933, with a chief complaint of "flu." Briefly, the present illness had begun three days previously with cough, a gradual onset of general malaise, restlessness and moderate fever. The prenatal history, as given in the mother's record, was entirely negative. The infant was born in this hospital on June 28, 1932, at term, spontaneously, weighed 10 pounds (4,535.92 Gm.), and was normal in all respects. Both the baby and the mother were discharged in good health. Following discharge, the baby continued to be fed breast milk for a month and later was given

18. Post.[2] Herrman.[8]

19. Peter.[1] Post.[2] Arkin and Sterling.[6] Herrman.[8]

20. Roche, W. J.: An Investigation of Miners' Nystagmus, Brit. J. Ophth. **15**:211 (April) 1931.

21. Post.[2] Yawger.[3] Arkin and Sterling.[6] Rabinowitsch.[7] Lebensohn.[11]

a physician's formula consisting of cow's milk, corn syrup and water. The child thrived on this formula.

In August 1932, the mother noticed that the baby, then 2 months old, nodded her head continually, and that the right eye twitched from side to side rapidly and continually. The head nodding and the nystagmus continued without interruption (while the baby was awake) for two months, during which the child developed well and had no illness. In October, the head-nodding stopped, but the right eye kept twitching until the baby was brought to the hospital on account of the "flu." She was 6 months old when admitted, and the nystagmus had been present for four and a half months. The familial history was noncontributory. The father was 40 years old, and the mother, 36; and both had been in good health. There were four siblings, 9, 7, 4 and 2 years old, all of whom were well. There had been no stillborn or premature children, and no miscarriages. Diabetes, from which the maternal grandmother died, was the only familial disease known. There had been no special eye troubles in the family, and certainly no nystagmus for three generations. Socially, financially and hygienically the family was the poorest of the country people. For several years past, they had lived under the most dire conditions. Their housing accommodation, lighting, food, clothing and general hygiene were poor and neglected. Despite this situation, the baby, having some outside help, had been properly fed and had had relatively good care.

Examination.—Examination of the patient showed her to be well developed and well nourished, of the given age, weighing 18¼ pounds (8,278 Gm.), rather acutely ill, listless, coughing hard at times, with a temperature of 99.4 F. The positive physical findings were: (1) a lateral nystagmus of the right eye, to be described later; (2) bilateral redness of the ear drums, without bulging; (3) a grayish nasal discharge; (4) a diffuse redness of the throat, and (5) coarse moist râles at the bases of the lungs, without any signs of consolidation of the lung parenchyma. The examination otherwise disclosed conditions entirely normal. A complete neurologic examination also yielded negative results. There was no head-nodding. The external examination of the eyes showed nothing of importance. The right eye was in constant, regular and rapid motion in a horizontal plane. The rate was too rapid to be correctly counted, but was certainly above 250 per minute. The rate became more rapid a few seconds after the child looked at an object on either side. Intensity of light did not affect the motion of the eye, but nervousness and upset increased the rate. Closing of the right eye produced no nystagmus in the left eye, and closing of the left eye did not influence the character of the nystagmus in the right eye. There was, by tests, good vision in both eyes. Ophthalmoscopic examination (without the use of a mydriatic, the pupils being well dilated at the time) showed no opacity in the lenses or in the media. The retinal vessels and the disks were normal. The nystagmoid movement of the right eye was apparent with the ophthalmoscope, but no such movement could be noted in the normal left eye.

Course.—The patient's course in the hospital was uneventful. The fever gradually subsided, the infection of the upper respiratory tract cleared up, the ear drums became normal, and the râles in the lungs disappeared. She was discharged from the hospital after three weeks, during which time no change in the character of the nystagmus was noted. A Wassermann test of the blood of the patient was reported as negative.

The case was followed at home. The child was seen on Feb. 27, 1933, a month after discharge, at which time she was reexamined, after about 10 drops of 3 per cent homatropine had been used in each eye for a quick and full dilation of the

pupils. The examination showed the same negative physical, and essentially the same ocular findings that were noted in the first examination. It was seen, however, that toward the end of the examination there was a definite slowing of nystagmus. At that time the child became restless and sleepy, so that further observation could not be carried out. A few days later, the mother reported to the family physician that following the use of homatropine the nystagmus had begun to slow down and continued slowing down until it stopped completely on the third day, and that it never recurred. The patient was visited, and the report verified by another examination. Since that time she has been seen every three months and examined at each visit. The condition has not recurred; there is no latent nystagmus, and no discernible abnormality of either eye. She has continued to develop well, and the mother states that she "is the brightest of the children." On Oct. 5, 1934, under atropine cycloplegia and by retinoscopy, the following lenses were found necessary to correct the refractive error: right eye, +0.75 sph. ⊃ +0.75 cyl., axis 90°; left eye, + 1.50 cyl., axis 90°. With the eyes tested individually, she could pick 2 mm. balls from her lap readily.

COMMENT

All writers agree that this condition is harmless and runs a favorable course after a duration of several months. The family is usually gravely concerned over the child's trouble, which may cause some harm or delay in the physical, mental or psychic development of the child, as yet unknown. It cannot be to the credit of a physician to see such a case and yet be unable to say or do anything about it.

According to Herrman,[8] congenital nystagmus appears commonly (75 per cent) in the first year of life, usually between the fourth and twelfth months. The majority of the cases begin in the sixth and seventh months.[8] He also observed that about 70 per cent of the cases appeared for the first time during the dark months of the year, December, January and February, and by far the greatest number in the first month of the year. His studies showed that the recurrences were almost always in January. As also observed by others, the greatest number of cases occur among the poor. It is stated that the reason the greatest number of occurrences are among the poor and during the dark period of the year is that in these homes artificial illumination is inadequate and the natural light is very poor for clear vision. The nystagmus resulting from such conditions is similar in cause and effect to the nystagmus seen among miners and that produced experimentally in young dogs. In all these groups the fundamental cause seems to be visual strain associated with long hours in dim and inadequate light. Fox's explanation (quoted from Lebensohn [11]) for such a belief is that "in dim light, vision is effected by means of the rods rather than the cones, and since there are no rods at the fovea, it is necessary for the axes of the eyes to be shifted constantly from their primary position." Speaking of miners' nystagmus, Cooke [22] reasoned similarly: "The generally accepted theory of causation is that in dim light the retina

22. Cooke, W. E.: Miners' Nystagmus, Brit. M. J. **1**:615 (April 11) 1931.

functions by means of the rods and not the cones. There are no rods at the fovea centralis, so that in a bad light the eye must move 15 degrees or more from its mid point to obtain the image of an object. Irregular reflections from the uneven coal surface and the constant maximum stress on accommodation contribute to the general eye strain." Similarly, Starling (cited by Roche [20]) stated "as a result of defective illumination the collier works with peripheral vision; he is trying to defeat nature, the periphery of the retina was never intended to be used." Rabinowitsch [7] expressed the belief that "it becomes more and more convincing that an insufficient quantity of light plays a great rôle in the development of monocular nystagmus." Catel [23] is of the same opinion.

In support of this theory of causation is the significant experimental work of Raudnitz (quoted from Herrman [8]). He placed newly born puppies in dark cages, and found that they acquired nystagmus in from six to eight weeks, and much later he noted head-nodding. If, however, the dogs were 2 months old before being subjected to the experiment, they did not acquire nystagmus. When the dogs with nystagmus of some weeks' standing were removed to good light, it was seen that the nystagmus disappeared in from one to two weeks. These same dogs began to show twitching of the eyes in from two to seven days afer they were returned to their original cages. The dogs that had had nystagmus continually for several months required to be in full light nine months or more before losing the nystagmus. The conclusions from the experiments are obvious and can be applied to infants.

On the basis of the generally accepted theory of the cause of nystagmus it is apparent that the twitching of the eyes is a physiologic reaction to unnatural external stimuli. "In formulating my theory as to the causation of nystagmus, I shall adhere strictly to physiologic facts and theories, as nystagmus is a nonorganic disease of the nervous system" (Starling, cited by Roche [20]). Moore [9] added the statement that "there is no associated disease of the eyes or nervous system" in congenital nystagmus. Thus the evidence seems to contradict the view of many writers that nystagmus is due to some abnormality in the visual circuit, even though an abnormality cannot be demonstrated. The abnormalities suggested were maldevelopment, trauma, degeneration, disease and toxicity. In the visual circuit were included the structures of the eye, the direct visual pathways and the indirect pathways, such as the vestibular apparatus, the cerebellum, the higher cortical centers and the centers associated with the movement of the head and the eyes.

The nystagmus, once it has developed, may be manifested in many ways. It may be continuous or periodic.[5] The rate also may vary.

23. Catel, W.: Zum Spontannystagmus des Neugeborenen, Deutsche med. Wchnschr. **58**:1478 (Sept. 16) 1932.

The speed and the amplitude of the component movements may be different. Usually both eyes are equally and similarly involved in one of the varieties: vertical, horizontal, rotatory or mixed; only rarely is twitching noted in one eye when the other eye is entirely normal. Rabinowitsch [7] expressed the belief that monocular nystagmus is a variety of the bilateral type, the movement of the eyes being independent. It is known that while one eye has an apparent nystagmus, the other may show the twitching when looked at with an ophthalmoscope; [2] or the other eye may have a latent nystagmus "manifested through accident, acute illness or nervousness," [20] or by closing the nystagmic eye; [4] or the eye may have no nystagmus at all as in the present case. According to Still (quoted from Post [2]), "nystagmus associated with head-nodding is usually more marked in one eye than in the other." Nystagmus may not be apparent in either eye, the twitching being in a latent form as in the case of Sorsby,[4] or visible only with an ophthalmoscope. One wonders how often children acquire these types and get over them without anything wrong ever having been detected.

The course of nystagmus depends on the nature and the course of the pathologic changes responsible for it. The cases of congenital nystagmus, although somewhat variable in their course, are "always recovered from." [9] If the nystagmus is of a latent type, manifested through a general illness, an upset or nervousness due to any cause, the twitching will often stop as or after the particular illness improves.[24] The usual types stop after a period varying between three and twelve months, usually six months. The improvement initiated, however, passes through the stages of slowing in the rate, then the stage in which the twitching can be seen only with an ophthalmoscope, and finally the stage of latency. In a small percentage of cases there is a recurrence of nystagmus,[6] which invariably appears in January.[8] The second attack may follow a variable course, too, but is usually much shorter. After the nystagmus finally stops, there are no residual ocular signs or symptoms. The patients develop well physically and mentally.

TREATMENT

Because of lack of common knowledge of the cause of congenital nystagmus there has been no prophylaxis, and the treatment of the condition has been misdirected. Correction of refractive errors and treatment of a coexisting condition have often failed to make any change in the course of the nystagmus. Spontaneous cures must, undoubtedly, have been attributed to some specific treatment which in reality had no influence. The patients in whom no pathologic change could be found usually went without treatment. Herrman,[8] using bromides, belladonna and arsenic as a means of reducing nervousness and as a means of

24. Post.[2] Arkin and Sterling.[6]

improving the general health, noted no influence on the nystagmus. The failure of such measures again points to the fact that the conception of the etiology was wrong.

In view of the striking similarity in cause between cases of nystagmus among infants and miners and experimental nystagmus in dogs, it is apparent that in children the same measures that have proved so satisfactory in the latter groups should be efficacious. These measures consist in giving the infant more and adequate light, so that he can see without having to use his peripheral vision. Increased artificial illumination or a change of location of the child so that he gets more natural light or even getting him outdoors for an appreciably long time are effective in prophylaxis as well as in treatment. For it is commonly agreed among the authorities on miners' nystagmus that improvement of light in the mines has remarkably reduced the incidence of nystagmus among the colliers. It is also noted by them that absence from the mine fairly frequently improves the nystagmus. The best proof that this belief is correct is the result of the experiments on young dogs already referred to. This simple treatment seems very worth while, and the sooner it is established the more immediate are the effects. It should be continued long enough, and certainly beyond the time when the nystagmus stops, because if the condition is in the externally invisible or in the latent stage, the chances of recurrence are higher if the child is returned to his unfavorable setting.

Direct measures in combating nystagmus were: correction of refractive error and attempts to remedy other ocular troubles. No priority is claimed here for the use of a mydriatic. The instillation of homatropine was made in order that a satisfactory examination of the eyes might be made. The satisfactory end-result was unexpected. Herrman [8] used atropine in a few of his cases and stated that he noted a slowing of the nystagmus, but he did not speak further about the final results, nor did he give any information about the subjects treated, the nature and the duration of their nystagmus or the duration of the treatment. Thomas [12] used atropine for refraction in two patients, aged 5 and 6 years, with nystagmus of a few years' duration. In the first child there was no change in the nystagmus for three years; the condition began to improve after that and disappeared a year later. The second child, with vision of 6/24 in each eye and a small degree of hypermetropic astigmatism, was given tinted glasses ("on the theory of albinism") after refraction with atropine. When seen eighteen months later, the nystagmus had not changed. Several months later it began to improve, and after a year it stopped completely. In my own case, homatropine produced contrastingly different results. A slowing in the rate of nystagmus was noted immediately. The improvement continued until the twitching stopped finally on the third day. The

nystagmus did not recur even though the child continued to live under the same conditions which had been responsible for the original attack, and which were so favorable for recurrence. The apparent effectiveness of this drug may have been related to the young age of the patient (8 months) at the time of treatment, and to the short duration of the nystagmus, which was six months. In these respects this patient was more favorable for treatment than those of Thomas.

The reasons that lead me to believe that homatropine possibly produced a direct effect on the nystagmus are: 1. The improvement began immediately after the instillation of the drug. 2. The nystagmus took such a rapidly favorable course. 3. A spontaneous cure was least likely in view of the unfavorable conditions of living. 4. The dark months of the year are the least favorable for a spontaneous disappearance of the condition. It is during these months that the recurrences take place, and the patient did not have a recurrence after the twitching had once stopped.

The modus operandi of homatropine as a remedial agent in nystagmus is unknown. One is not justified in deriving any conclusions from the results in one case. The end-result, however, is highly suggestive. This case is reported primarily to interest others more fortunate in opportunity to see similar cases and to test the value of this drug or of other mydriatics in the treatment of congenital nystagmus. Further studies along the lines suggested in this paper will shed light on the question.

SUMMARY

A report is made of a rare case of monocular horizontal nystagmus in a healthy infant of 8 months, with the nystagmus beginning at the age of 2 months. The condition was not associated with the pathologic states usually considered the cause of nystagmus. It is shown how infants, as do miners and experimental dogs, in a physiologic reaction to dim and inadequate light, can and do acquire nystagmus in one of the many forms, how the condition can be prevented, and how, once established, it can be favorably treated by effecting clear vision by means of better light. It is suggested, on the basis of the experience in this case, that instillation of a mydriatic in the eyes may be a direct and immediate step in the treatment of nystagmus. The literature on the subject is reviewed.

Clinical Notes

CHRONIC UNILATERAL HYPERTROPHIC CONJUNCTIVITIS

A Case for Diagnosis

ABRAHAM FINE, M.D., BROOKLYN

The following unusual case of chronic unilateral hypertrophic conjunctivitis presents many features of considerable interest. The unfortunate termination in complete loss of sight marks the problem as a practical one, worthy of more than mere academic consideration. Despite extensive pathologic studies conducted both at the Manhattan Eye and Ear Hospital and at the Knapp Memorial Eye Hospital, the condition remains undiagnosed and offers a challenge to ophthalmologic knowledge.

REPORT OF CASE

History.—A man, aged 32, a dressmaker, had a cold in the head in May 1932, which lasted about ten days and was associated with redness, itching and tearing of both eyes. The condition resembled in some respects the autumnal attacks of hay fever which the patient had had for the past five years. There was no fever, chills, vomiting or other constitutional disturbance. He gave no history of trauma to the eye or of contact with animals. The past history revealed the following data: typhoid at the age of 17 and syphilis three years before examination for which he received two intensive courses of treatment. The family history was unimportant.

The condition in the left eye cleared up promptly, but the right eye continued to tear and remained congested. At the Manhattan Eye and Ear Hospital the patient was treated with astringents, and as he failed to improve 50 milligram minutes of radium was applied to the upper and lower lids on June 6. About five days later the glands in front of the right ear and in the right side of the neck became tender and enlarged, remaining so for several months. There was no fluctuation at any time. The radium treatment had an unfavorable effect on the eye as well, for the lids became swollen, and the discharge, at first watery and scant, became purulent and profuse. The Wassermann reaction was 4 plus in June, but after thorough antisyphilitic treatment at the hospital it became negative, and remained so. In October 1932 the patient was discharged from the hospital with a diagnosis of Parinaud's disease and syphilis.

At the Knapp Eye Hospital, where the patient came under my attention, in the latter part of October, the following condition was noted: The lids of the right eye were red and edematous, occluding the globe, and the margins were covered with a profuse mucopurulent discharge. The right side of the face was swollen; slight enlargement of the parotid gland without tenderness or fluctuation was noted, but the submaxillary and cervical nodes were not hypertrophied.

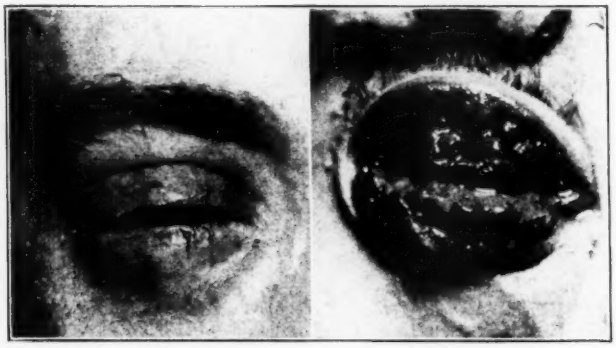
Eversion of the lids, accomplished with difficulty, revealed tremendous hypertrophy of the conjunctiva. In the lower lid were seen several large ulcerated

---

Presented before the New York Academy of Medicine, Section of Ophthalmology, January, 1932.

areas (the result of removal of biopsy specimens), covered with purulent secretion. The upper lid, which had not been touched, revealed the nonulcerative lesion more strikingly; it was deep red, and on the tarsal surface broad, soft granulations, some polypoid, with deep furrows, were seen, which did not invade the fornix conjunctiva. The bulbar conjunctiva was deeply congested, and near the temporal limbus were several granulations. The cornea appeared dull, and superficial vascularization extended for 2 to 3 mm. beyond the upper and the lower margin. With a 1 per cent aqueous solution of fluorescein, a fine superficial stain of the entire cornea was disclosed. The pupil was widely dilated, and the fundus showed no abnormality. Corrected vision in the right eye was 20/200 and in the left 20/30. Except for photophobia and tearing the left eye was normal.

The subsequent course consisted in a progressive loss of sight. The hypertrophic lesion of the lids remained unchecked. The granulations involved the bulbar conjunctiva and finally spread over the cornea. When the patient was seen on March 1, 1934, after a course of high voltage roentgen and radium treatment, the edema of the lids and the hypertrophy of the conjunctiva were much



Preauricular swelling and closure of the eye caused by edema and hypertrophy of the conjunctiva.

reduced. All vision except for perception of light and for projection was gone in the right eye, which had lost all appearances of normal structure. The patient's general condition remained good through his illness.

Laboratory Data.—The physical examination gave essentially negative results. Smears and cultures revealed at one time a gram-positive organism resembling Bacillus xerosis and at a later date Staphylococcus aureus. A biopsy done early in the illness showed ulceration of the mucosa execept several small areas of cells. The submucosa consisted of fibrous stroma, densely infiltrated with plasma cells and eosinophils. In areas there were numerous lymphocytes. The plasma cells in areas showed hydropic degeneration, and in some places there was necrosis of the tissues. No definite giant cells were noted. A diagnosis of chronic granuloma was made (Dr. Eggston). Another biopsy, done by Dr. Fink in December 1932, revealed similar changes.

The Wassermann reaction, which was 4 plus in June, became negative several months later and remained so. Tuberculin tests were negative. Two guinea-pigs were given injections of macerated tissue from the conjunctiva and showed no

ill effects. Examination of tissue revealed no tubercle bacilli. Two specimens of serum, taken at different times during the illness, were sent to Washington for agglutination against Bacillus tularensis and were reported as negative. Examination of the blood showed: white cells, 12,000; polymorphonuclears, 69 per cent; lymphocytes, 28 per cent; eosinophils, 3 per cent. The urine was normal. The allergic background studied by Dr. Messer revealed the following responses to tests: ragweed, short and giant, 4 plus; red top, timothy, June and orchard grass, 3 plus; chicken feathers, 2 plus, and orris root, 1 plus.

Treatment.—Treatment included the use of mercurochrome 2 per cent; applications of copper sulphate and silver nitrate; injections of milk; fourteen injections of arsphenamine and two of a bismuth preparation; large doses of potassium iodide; injections of autogenous vaccines, and radium treatment with high voltage roentgen radiation.

Differential Diagnosis.—Tuberculosis, I believe, can be ruled out because of the negative results of physical examination, tuberculin tests, guinea-pig inoculations and failure to isolate the organism in the tissues or on culture. Furthermore, the clinical picture of tuberculosis of the conjunctiva is essentially that of a chronic sluggish ulcer.[1]

The failure of clinical improvement, in fact, the continued retrogression, despite a Wassermann reaction made negative by treatment, argues against syphilis as the direct etiologic agent. Only one case of definite syphilitic granuloma of the conjunctiva is reported in the literature.[2] After two injections of arsphenamine, the patient made a complete recovery.

A diagnosis of Parinaud's conjunctivitis cannot be supported for the reason that no such clinical entity exists. When Parinaud,[3] in 1889, presented several cases of a hitherto undescribed condition he offered no bacteriologic or histopathologic studies. Subsequently, certain observers found tubercle bacilli and others Bacillus tularensis, and recently Verhoeff [4] isolated Leptothrix in cases which resembled the condition described by Parinaud. It appears, therefore, that the term "Parinaud's syndrome," as indicative of a chronic unilateral conjunctivitis with regional adenopathy, would be more accurate.

The oculoglandular form of tularemia [5] leaves little doubt of its existence when present. There is usually a history of contact with animals and a sudden onset attended with moderate or high fever, chills, vomiting and prostration. Discrete, punched-out ulcers appear in the tarsal conjunctiva. Guinea-pigs inoculated with conjunctival scrapings die within a week and small, white, necrotic spots are found in the liver and spleen. The serum of the patient agglutinates with Bacillus tularensis after the first week of illness.

---

1. Fuchs, E.: Tuberculosis of the Conjunctiva, in Text-Book of Ophthalmology, ed. 8, Philadelphia, J. B. Lippincott, 1924, p. 494.

2. Goar, E. L.: Syphilitic Granulations of the Conjunctiva, Am. J. Ophth. **11:** 42 (Jan.) 1928.

3. McKee, S. H.: Parinaud's Conjunctivitis, Tr. Am. Ophth. Soc. **25:**236, 1927.

4. Verhoeff, F. H.: Observations on Parinaud's Conjunctivitis (Leptothricosis Conjunctivitis), Am. J. Ophth. **1:**705 (Oct.) 1918.

5. Vail, D. T., Jr.: Oculo-Glandular Form of Tularemia, Illinois M. J. **57:** 244 (April) 1930.

Necrotic infectious conjunctivitis (Pascheff's disease)[6] clinically resembles tularemia, but according to Pascheff the organism has cultural characteristics distinct from Bacillus tularensis. Both of these conditions could reasonably be ruled out.

Special cultures were made in accordance with the technic advised by Verhoeff in an attempt to isolate Leptothrix, but were unsuccessful. Sporotrichosis could not be demonstrated. The existence of a new growth could not be proved. Unilateral trachoma or vernal catarrh, affecting one eye and causing its destruction, were both extremely unlikely.

CONCLUSION

In reviewing the literature, I could find but one case, reported by Wright,[7] with features closely resembling the case presented. The subject was also syphilitic and antisyphilitic treatment had been of no avail. A significant point in the case I have presented is the patient's allergic background. His condition started with symptoms similar to his autumnal attacks of hay fever. Pathologic studies revealed an allergic reaction,[8] i. e., the presence of a large number of eosinophils, plasma cells and lymphocytes. The differential count showed 3 per cent eosinophils. It would be interesting if observers encountering similar cases would investigate the presence of any allergic tendency. This may have been either coincidental or an important contributory factor.

6. Pascheff, C.: Differential Diagnosis Between Conjunctivitis Necroticans Infectiosa and Conjunctivitis Tularensis, Am. J. Ophth. **10**:737 (Oct.) 1927.

7. Wright, R. E.: Obscure Affection of the Conjunctiva Resembling Cases of Parinaud's Syndrome, Arch. Ophth. **54**:280 (May) 1925.

8. Lehrfeld, L.: Allergic Reactions in Vernal Conjunctivitis, Am. J. Ophth. **8**:368 (May) 1925.

CONTACT GLASS FOR USE IN OPERATIONS ON RETINAL DETACHMENT

MIKLOS KLEIN, M.D., BUDAPEST, HUNGARY

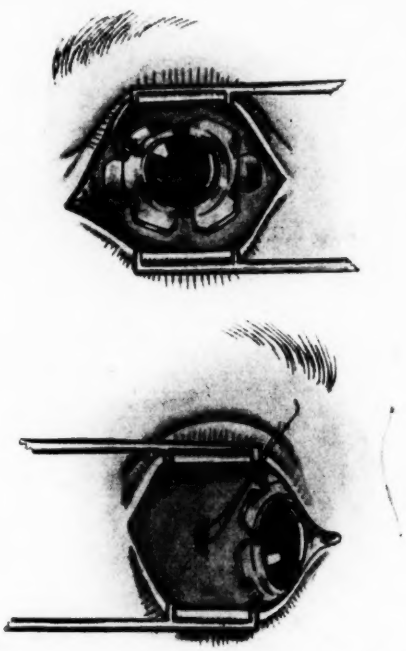
In the present method of treatment of retinal detachments by diathermic punctures it is important to control the placing of the perforations by simultaneous observations with the ophthalmoscope. It is therefore essential that the transparency of the cornea should not be impaired during the operation, otherwise ophthalmoscopy is impossible. To obviate the drying of the cornea a Zeiss contact glass has been applied to the globe. The use of the regular Zeiss contact glass, however, entails several difficulties: One must dispense with the directive suture at the limbus, and one must perform the measurement of the chord distance

Edited by Dr. Benjamin Friedman, New York.

From the Department of Ophthalmology, Jewish Hospital.

from the limbus against the glass. Also, if the operative field lies nasally or temporally, the application of the Zeiss contact glass is impossible because the wide scleral part touches the palpebral angle when the globe is turned aside, and the glass is simply lifted up.

I have attempted to remedy these deficiencies by a modified contact glass which consists of a regular corneal part and a narrow scleral part. The contact glass is oval-shaped, the length of the major axis being 18 mm., while that of the minor axis is 14 mm. The glass is fastened to the globe by silk sutures which pass over notches at the ends of the oval. When one operates on the side, the glass can be sewed with the



In the upper drawing, the contact glass is shown sewn on the globe, the major axis of the oval horizontal. In the lower drawing, the contact glass lies with the minor axis vertical, and the globe is turned aside.

major axis placed vertically or diagonally. There are, in addition, two notches on the broad edges of the glass to allow for measurement of the chord distance with a compass or with the instrument of Professor Imré or for placement of the directive suture.

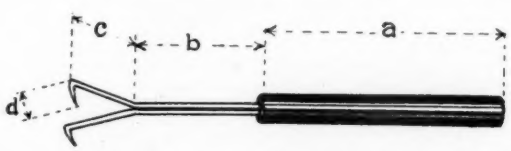
After exact localization of the retinal hole, one marks the meridian on the two opposite parts of the limbus with india ink. A drop of salt solution is placed in the concavity of the glass and it is then held in the usual manner against the globe. It is next sewed so that the meridional markings coincide with the minor axis of the oval. As already mentioned, the contact glass may be sewed on at any inclination, so that its usefulness is assured no matter where the site of operation.

AN ELECTRODE WHICH SIMPLIFIES THE TECHNIC OF ELECTROSURGICAL TREATMENT OF RETINAL DETACHMENTS

MARK J. SCHOENBERG, M.D., NEW YORK

The Šafář and Walker electrodes have been in use a sufficient length of time to prove their worth. However, they have certain shortcomings:

1. Some of the Šafář electrodes consisting of one, two or three points are difficult to handle. They slip from the hold of the forceps and may get lost in the wound or become caught in the meshes of gauze or cotton. 2. The hard insulating varnish covering base, into which the short needle points are fastened, becomes brittle, cracks and peels off, and the danger of losing these particles of varnish in and outside the eyeball, though remote, is always present. 3. The thorough cleansing of the points is almost impossible unless much time and care are devoted to this work. 4. The sharpening of the points is very difficult. 5. Ideal sterilization by high temperature or a Bunsen burner is not practicable. 6. Finally, the application of the four to six point



Schoenberg two hook electrode. *a* is 24 mm. long and 2.5 mm. thick; *b* is 15 mm. long and 1 mm. thick and can be bent; *c* is 6 mm. long. The depth of penetration (*d*) is 1.25 mm. The distance between the two points of the electrode is 3 mm.

brush electrode becomes more difficult the nearer to the posterior pole it is to be inserted.

The Walker single point electrodes ("micropins") overcome several of the disadvantages of the Šafář electrodes. They can be completely sterilized and cleansed in the flame of a Bunsen burner, and by the aid of a special carrier they can be easily applied. But if used without being attached to threads they may get lost. "Reports of loss of micropins without threads attached are numerous."[1] It requires a considerable amount of dexterity and cooperation on the part of assistants and nurses to keep the threaded micropins from becoming tangled, a fact which must have induced Dr. Walker to give up the thread and use the micropins unattached (Dr. Walker's[2] paper read at the meeting

1. Walker, Clifford: Retinal Detachment, Am. J. Ophth. **17**:1 (Jan.) 1934.

2. Walker, Clifford: New Devices and a Modification for Diathermic Operation and Localization in Separation of the Retina, Arch. Ophth. **12**:970 (Dec.) 1934.

of the American Medical Association, Cleveland, 1934). However, in the hands of less experienced surgeons the use of unthreaded micropins may be dangerous.

Realizing the shortcomings of the Šafář and Walker types of electrodes, I have designed and used a single two hook electrode. The drawing illustrates this electrode.

The points of the hooks penetrate the sclera in an oblique direction. The purpose of this feature is to obviate the sudden escape of the subretinal fluid and rapid collapse of the eyeball. In the cases in which this type of electrode has been used the fluid escaped slowly and in small amounts, and the operation could be finished with great ease. The advantage offered by the double hook electrode is especially appreciated in cases with tears situated far back, nearer the posterior pole. In cases of this kind in which torsion of the eyeball is very difficult, the hook electrode performs the double function of electrode and retractor. As the points of the hook are inserted in the superficial layers of the sclera, the current is released and the points penetrate the sclera; a slight traction rotates the posterior pole forward to the desired degree.

This electrode may be made to fit any handle and is applied like any of Šafář's brush electrodes. The applications can be made rapidly along the line surrounding the area of the retinal tear. The points of the electrode, being very smooth and sharp, puncture the sclera with great ease, almost without any pressure, even if the eye is soft.

There is no insulation material around this hook electrode, and the flame of a Bunsen burner sterilizes and cleanses it thoroughly. If attention is given to the proper technic of turning on the current only after the points of the electrode are stuck into the superficial layers of the sclera, the points do not become dulled and gritty by a covering of carbon. The current, concentrating mainly on the pointed ends of the hook, does not leak to any appreciable or damaging amount along the rest of the instrument. The current used is regulated by setting the indicator of the power control dial at from 30 to 35 and of the selector switch dial at R. D. (retinal detachment). The advantage of this current is that it has both the coagulating and the cutting quality. The latter facilitates the penetration of the points of the hook electrode.

Since using the double hook electrode, I have had no occasion or desire to return to the use of other types of electrodes.

This electrode is of stainless steel or platinum iridium and is made by Liebel-Flarsheim of Cincinnati.

Ophthalmologic Review

CHRONAXIA AND THE EYE

LEO L. MAYER, M.D.
CHICAGO

A new doctrine of physiologic investigation has appeared. It concerns more especially the activity of muscles and nerves in relation to electrical stimulation. The groundwork was brought forth by Lapicque [1] in his experimentation with nerves and nerve-muscle preparations. Of more recent date has been its practical application in neurology. Now its premises are creeping into ophthalmology as they relate to the musculature of the face, the extra-ocular muscles, the instrinsic muscles of the eye and, finally, the retina and optic pathways.

The term "chronaxia" may be defined as the time during which a current of twice the threshold intensity (i. e. two times as strong as the constant current which causes a minimal stimulation) must flow to produce a minimal stimulation. In this brief outline I shall attempt to explain in simple language the doctrine of chronaxia as it concerns the eye. An introduction into this subject is entirely lacking in American ophthalmologic literature. Fredericq,[2] Fulton [3] and Evans [4] have discussed the general subject in English and Adler [5] and Duke-Elder [6] have commented on it in regard to the eye. The original work of Lapicque and the studies of his pupil, Bourguignon,[7] of Verryp [8] and

From the Department of Nervous and Mental Diseases and the Department of Ophthalmology, Northwestern University Medical School.

1. Lapicque, L.: L'excitabilité en fonction du temps, Paris, Presses Universitaires de France, 1926.

2. Fredericq, H.: Testing Excitability by Means of Time Factor, Physiol. Rev. **8**:501, 1928.

3. Fulton, J. F.: Muscular Contraction and the Reflex Control of Movement, Baltimore, Williams & Wilkins Company, 1926, p. 78.

4. Evans, C. L.: Recent Advances in Physiology, Philadelphia, P. Blakiston's Son & Co., 1930, p. 295.

5. Adler, F. H.: Clinical Physiology of the Eye, New York, The Macmillan Company, 1933, p. 6.

6. Duke-Elder, W. S.: Textbook of Ophthalmology, St. Louis, C. V. Mosby Company, 1933.

7. Bourguignon, G.: Un nouveau chapitre en électrodiagnostic; La chronaxie du système optique chez l'homme, Congrès de l'Association française pour l'avancement des sciences, Grenoble, 1926, p. 116.

8. Verryp, C. D.: Handbuch der Geisteskrankheiten, Berlin, Julius Springer, 1928, vol. 1, 352.

of Noyons are found in the French. In German the general subject has been fully outlined by Quicke and Stein,[9] Altenburger and Kroll,[10] and Hofe and Fisher;[11] the eye has been considered more especially by Kroll [12] and Kreindler and Brecher [13] and particularly by Linksz.[14] In this presentation all the aforementioned authors and others have been consulted frequently, and their ideas and explanations are transcribed without apology.

In 1848 DuBois-Reymond,[15] one of the pioneers of electrophysiology, established the law of excitability, using what is known as the physiologic rheoscope, the nerve-muscle preparation of the frog. Because of his great influence the question as to whether the duration of the current was a factor of the stimulus threshold was entirely overlooked for a long time. Fick [16] in 1853 and von Brücke [17] in 1867 demonstrated that a stimulating current becomes inefficient if it is applied for too short a time. In 1870 Engelmann [18] succeeded in demonstrating that with a decrease in the stimulus time the effect is also diminished. It remained for the Dutch physicist Hoorweg [19] to show the inadequacy of DuBois-Reymond's law. With the use of condensor discharges of extremely short but measurable duration the time element or duration of the stimulating current became of as much importance as the strength of the current. Weiss [20] evolved a new formula for excitability which the ingenuity of Lapicque shaped into the doctrine of chronaxia.

9. Quicke, H., and Stein, J.: Chronaxie, Ergebn. d. Physiol. **34**:907, 1932.

10. Altenburger, H., and Kroll, F. S.: Die vegetative Beeinflussung des optischen Systems. (Zugleich eine Methode zur Bestimmung der Intensitäts- und Zeitschwelle mit adäquaten Lichtreizen), Ztschr. f. d. ges. Neurol. u. Psychiat. **124**: 527, 1930.

11. Hofe, and Fisher, F. P.: Ber. ü d. Versamml. d. deutsch. ophth. Gesellsch., 1893, p. 120.

12. Kroll, F. W.: Electrotomische Erregbarkeitsveränderungen des optischen Systems, Ztschr. f. d. ges. Neurol. u. Psychiat. **125**:134, 1930.

13. Kreindler, A., and Brecher, I.: Die Chronaxie des pathologisch veränderten optischen Systems, Arch. f. Ophth. **129**:250, 1932.

14. Linksz, A.: Ueber Chronaxie, Zentralbl. f. d. ges. Ophth. **29**:401, 1933.

15. DuBois-Reymond, E.: Untersuchungen über thierische Electricität, Berlin, G. Reimer, 1848.

16. Fick, A., and DuBois-Reymond, P.: Ueber die unempflindliche Stelle der Netzhaut im menschlichen Auge, Arch. f. Anat. u. Physiol. 1853, p. 396.

17. von Brücke, E. T.: Ueber das Verhalten entnervter Muskeln gegen discontinuierliche elektrische Ströme, Sitzungsb. d. k. Akad. d. Wissensch. Math.-naturw. cl., 1867, vol. 56; 1868, vol. 58.

18. Engelmann, T. W.: Sur le mouvement péristaltique de l'urétère, Arch. néerl. d. sc. exact et natur. **4**:126, 1869.

19. Hoorweg, J. L.: Die medizinische Electrotechnik und ihre physikalischen Grundlagen, Leipzig, Wilhelm Engelmann, 1893.

20. Weiss, G.: Sur l'excitation électrique des nerfs, J. de physiol. et de path. gén. **5**:238, 1903.

Instruments known as chronaximeters have been devised by Lapicque, Noyons,[21] Lucas,[22] Strohl [23] and Helmholtz.[24] A detailed description of these instruments would be out of place here. Suffice it to say that an accurate measurement of the strength and especially of the duration of an electrical discharge may be obtained in these instruments. The variations in resistance of living tissue to these electrical discharges disappeared when a strong resistance, of from 15,000 to 20,000 ohms, was introduced into the current. From the formula devised by Lapicque a chronaxia value in sigmas (1 sigma equals one one-thousandth second) may be determined for any nerve or muscle or for a combination of these structures. It was shown that each normal tissue has its specific chronaxia and that any interference by a mechanical or pathologic process alters this chronaxia. The classic experiment with curare and strychnine demonstrated that the former increases the chronaxia of the muscle without changing that of the nerve while strychnine decreases the chronaxia of the nerve alone and leaves that of the muscle unchanged.

Bourguignon [25] experimented with the entire musculature of man and established the following laws:

1. All muscles which in an action work together as synergists form a separate group characterized by having the same chronaxia (functional isochronism).

2. Agonists and antagonists have a proportional chronaxia of 1:2 or 1:3 (functional heterochronism).

3. The chronaxia of muscles of the ventral part of the body is smaller than that of the dorsal half. (On the arm the flexors and on the leg the extensors have the smaller chronaxia).

4. The proximal parts of the body have smaller chronaxias than the distal parts.

5. The thicker a muscle, the quicker its irritability and the smaller its chronaxia.

6. On the basis of chronaximetric behavior the muscles in man are divided into four groups as follows:

Muscles of the proximal region:
(1) Ventral, from 0.06 to 0.14 sigma
(2) Dorsal, from 0.16 to 0.34 sigma
Muscles of the distal region:
(1) Ventral, from 0.16 to 0.34 sigma
(2) Dorsal, from 0.40 to 0.70 sigma

---

21. Noyons, A. K., and Verryp, C. D.: Description d'un appareil pour mesurer la chronaxie, Compt. rend. Soc. de biol. **90**:948, 1924.

22. Lucas, K.: The Analysis of Complex Excitable Tissues by Their Response to Electric Currents of Short Duration, J. Physiol. **34**:310, 1906-1907.

23. Strohl, A., and Desgrez, H.: Recherches sur la forme des courants employés pour la mesure de l'excitabilité électrique chez l'homme, J. de radiol. et d'électrol. **12**:113, 1928.

24. Helmholtz, H. L.: Handbuch der physiologischen Optik, Hamburg, Leopold Voss, 1909-1911, vol. 2, p. 455.

25. Bourguignon, G.: La chronaxie chez l'homme, Paris, Masson & Cie, 1923.

7. For every animal species and for man there are, in general, three values for chronaxia:

A. Small chronaxias, from 0.06 to 0.14 sigma
B. Medium chronaxias, from 0.16 to 0.34 sigma
C. Large chronaxias, from 0.40 to 0.70 sigma

How does all this concern the ophthalmologist? Before entering this phase of the subject it is necessary to comment on experiments made with electrical current used previously in testing the irritability of the eye. In 1838 Johannes Müller [26] in his "Handbuch der Physiologie des Menschen" dealt with the product of a stimulation, a phenomenon of light called phosphene. He found that with the opening or closing of a galvanic circuit in which an eye was situated a lightning-like light was perceived. He called attention to the fact that earlier workers, including Ritter,[27] Hjort [28] and particularly Purkinje, [29] had carried out experiments on localization of this light phenomenon in the visual fields. Following Müller, Helmholtz in his monumental work presented the existing knowledge concerning the electrical phosphene. Helmholtz mentioned condensor discharges as producing phosphenes. Hoche [30] determined the threshold of stimulation with a galvanic current (without regard to the time factor). He recorded the strength of the current required for the production of a phosphene as from 0.02 to 0.025 milliamperes. Darier [31] investigated diseased eyes. In a case of optic atrophy an increase in the stimulus to 10 milliamperes was necessary to produce a phosphene.

It is here that the doctrine of chronaxia as it relates to the optic pathways enters the field. Bourguignon's contribution, supported by the teachings of Lapicque, has created for the ophthalmologist a new and as yet little known method, which, however, has not received universal acceptance. Additional basis for his work was supplied to Bourguignon by the experiments of Dubois,[32] Mann [33] and Hoorweg.[19]

---

26. Müller, J.: Handbuch der Physiologie des Menschen, Berlin, Georg Thieme, 1838.

27. Ritter, quoted by Müller, J.: Elements of Physiology, translated by W. Baly, London, Taylor and Watson, 1842, vol. 2, p. 1212.

28. Hjort, quoted by Müller.[27]

29. Purkinje, J. E.: Neue Beiträge zur Kenntnis des Sehens in subjektiver Hinsicht, ed. 2, Berlin, J. G. Calve, 1823.

30. Hoche, quoted by Kreindler and Brecher.[13]

31. Darier, quoted by Polland and Vitek.[37]

32. Dubois, R.: A propos de la transmission humorale des excitations nerveuses, Compt. rend. Soc. de biol. **97**:634, 1927.

33. Mann, L., and Kramer, F.: Neuere Erfahrungen auf dem Gebiet der medizinischen Elektrizitätslehre mit Ausschluss der Röntgenlehre, Berlin, Georg Thieme, 1828.

In their investigation Bourguignon and his co-workers [34] proceeded from the determination of the threshold intensity of the constant current which, when allowed to flow through the eye, is able to produce a phosphene. They found that the value for this threshold could be easily and very accurately determined and that it could be exactly localized by the person experimented on. Exception has been taken to the latter statement. One may become familiar with the difficulties of localizing phosphenes by stimulating the closed lids with point electrodes by means of a mild galvanic current. Since it is impossible to fix the stimulus electrode to the eye as it is usually fixed on the body, it was necessary to fix the gaze and in this way assure the fixation of the eye. Bourguignon and his co-workers found that when this is done the localization of the phosphene is dependent only on the position of the stimulating electrode. According to Bourguignon if any point of the eye is electrically stimulated through the lid with the eye open and the gaze straight forward, the phosphene appears in the same direction (local phosphene). When the electrode is placed on the center of the cornea a phosphene occurs in the anteroposterior axis (central phosphene); when the electrode is placed on any point on the sclera a phosphene occurs in the same direction (peripheral phosphene).

Phosphenes of an entirely different nature are supposed to result when the subject looks sharply to one side, so that the posterior pole of the eye is brought as closely as possible to the orbital margin and the stimulus electrode as near as possible to the optic nerve. With this arrangement the phosphenes are supposed to occur, not under the electrode, but farther away (distant phosphenes [*phosphènes à distance*]), namely, either peripherally—in the opposite sector of the bulb—or centrally—in the optic axis.

According to Bourguignon and his co-workers the distant phosphenes are supposed to occur "through stimulation of the papilla" of the third multipolar neuron and also through an indirect stimulation of the retina "comparable to the stimulation of a muscle through its nerves," and are therefore also called indirect phosphenes, whereas the first discussed local phosphenes, which occur through direct stimulation of the retina or of the second bipolar neuron, are called direct phosphenes. The peripheral phosphenes are the expression of a (direct or indirect) stimulation of the rods of the periphery of the retina; the central ones are the result of a stimulation of the cones of the fovea.

This changeable localization of the phosphenes permits a study of the irritability of various regions of the retina. It was shown that the

34. Bourguignon, G.; Courland, M., and Dejean, R.: Phosphènes locaux et phosphènes à distance, Egalité de chronaxies correspondantes, Compt. rend. Soc. de biol. **94**:753, 1926.

chronaxia of the eye—in this case, the time during which a current of twice the threshold intensity must flow to produce a minimal perception of light—is higher than that of any other of the organs thus far studied but that there are considerable differences, depending on whether the phosphene is localized centrally or peripherally. According to the studies of Bourguignon and Dejean, the chronaxia of the peripheral phosphenes (phosphenes of the periphery of the retina), produced both directly and indirectly, amounts to from 1.2 to 1.8 sigmas, the chronaxia of the central—direct or indirect—phosphene (phosphene of the center of the retina), to from 2.1 to 2.7 sigmas. Since studies by Kleitman and Pièron [35] indicate that the rods react more quickly than the cones and since, according to the aforementioned results of Lapicque, quickly reacting organs possess smaller chronaxias. the assumption was at hand that the small chronaxia belongs in the periphery to the neurons of the rods and the greater chronaxia, in the center to the neurons of the cones. The rods and cones themselves are supposed to be nonirritable with the inadequate electrical stimulus.

Kreindler and Brecher,[13] who used the Helmholtz pendulum, in place of condensator discharges, have confirmed these results in their entirety. They also found differences in the chronaxia of the peripheral and of the central appearing phosphenes (with direct as well as with indirect stimulation) and gave as corresponding values from 1.2 to 1.8 and from 2.2 to 3.0 sigmas, respectively. This heterochronism of about 1:2 applies also as a symbol of the different irritability or of the accepted antagonism of rods and cones.

One can add here that the results of Bourguignon were confirmed by German investigators so far as the latter were also able to find values for chronaxia of similar magnitude for the eye, whereas they are skeptical about the possibility of an exact subjective localization of the phosphene and therefore the differentiability of central and peripheral irritability. However, certain German investigators, namely, Kreindler and Brecher, have gone so far as to consider the measurement of these localized phosphenes as a direct aid in diagnosing diseases of the eye and lesions of the optic pathways. They have recently shown a change of chronaxia in such conditions as optic atrophy, papillitis, choked disk, retrobulbar neuritis, detachment of the retina, choroiditis and chorioretinitis. In tabetic atrophy of the optic nerve the pathologic process is supposed to be transposed to multipolar neurons, on the basis of the isolated changes of the indirect irritability. Kreindler and Brecher give interesting reports concerning two cases of cataract, in which, on the basis of the chronaximetric behavior they

35. Kleitman, N., and Pièron, H.: Loi de variation de la durée de la première phase dans l'établissement de la sensation pour des excitations lumineuses croissantes des cônes et des batonnets, Compt. rend. Soc. de biol. **91**:456, 1924.

assumed that a disease of the posterior part of the bulb was present. The bad prognosis given was later verified by the findings of an old chorioretinitis.

Achelis and Merkulow [36] have reemphasized the fact that the electrical stimulus acts not on the sensory epithelium, but rather on parts which lie centrally. The exact proof was found in the fact that the threshold of electrical stimulation in cases of dark adaptation constitutes many times that for the eye adapted to light. They were unable to localize a phosphene and therefore could draw no conclusions concerning the chronaxia of the rods and cones.

Mention should be made of the experiments of Polland and Vitek [37] who concluded that the optic nerve forms the point of stimulation but that stimulation of the retina is difficult to exclude.

Best's [38] experiment appears to refute this last claim. He was unable to produce any effect on the optic nerve stump of a seeing eye which had just been enucleated. This observation was confirmed by Hofe and by Fischer.[11] Last and Laubenthal [39] were unable to confirm the double chronaxia of the optic apparatus because of the difficulty of localizing the phosphenes.

Rizzolo [40] has discovered an optimal point of motor stimulation in the cortex for eliciting the lid reflex. When a change is produced by the injection of morphine or the instillation of cocaine into the conjunctival sac a marked change is found in the chronaxia of the orbicularis oculi.

The Dutch ophthalmologist Zeldenrust [41] has delved into the subject of the pupillary chronaxia in relation to the light reflex. Hess,[42] in his work with the differential pupilloscope, had somewhat set the stage for such a work. By developing his own pupilloscope, called a "chronopupilloscope," Zeldenrust found the chronaxia of the pupil in twenty-six normal persons to be from 32 to 51 sigmas. In patients with dementia paralytica, cerebral syphilis and tabes the chronaxia was

---

36. Achelis, J. D., and Merkulow, J.: Die elecktrische Erregbarkeit des menschlichen Auges während der Dunkeladaptation, Ztschr. f. Psychol. u. Physiol. d. Sinnesorg. (Abt. 2) **60**:95, 1929.

37. Polland, B., and Vitek, J.: Untersuchung der Sehnerven mittels Kondensatorenerhebungen, Zentralbl. f. d. ges. Ophth. **18**:156 and 637, 1927.

38. Best, F.: Ist der Sehnerv elektrisch reizbar? Ber. ü. d. Versamml. d. deutsch. ophth. Gesellsch. **49**:239, 1932.

39. Last, S. L., and Laubenthal, F.: Verhandl. d. Gesellsch. deutsch. Nervenärzte, 1932, p. 106.

40. Rizzolo, A.; Chauchard, A., and Chauchard, B.: Action de la cocaine sur les centres corticaux, Compt. rend. Soc. de biol. **95**:605, 1926.

41. Zeldenrust, E. L. K.: Ueber die Chronaxie des Lichtreflexes der Pupille, Arch. f. Augenh. **104**:585, 1931.

42. Hess, C.: Das Differential-Pupilloskop, Arch. f. Augenh. **80**:213, 1916.

increased. Changes in the chronaxia are also to be found much earlier than those of the rheobase at the beginning of an Argyll Robertson pupil. Naturally perception does not enter into this type of work, and the subjective phase is eliminated. Zeldenrust's conclusion, from the differences in the pupillary chronaxia (from 32 to 51 sigmas) and electrical phosphenes (2 sigmas), that special fibers exist in the optic nerve, seems hardly valid in view of the work of Grijns and Noyons [43] and Altenburger and Kroll. Altenburger and Kroll have given values of the same magnitude for the chronaxia of the adequate light stimulus by stimulation of the fovea.

A review of the excellent accomplishments of Stein [44] would lead too far afield, but the chapter on the pathologic changes in perception in the "Handbuch der Geiteskrankheiten" is especially recommended for those who wish to delve further into this entire subject.

Poole's [45] experiment, while it has never been confirmed or contradicted, appears to throw some doubt on the measurements of the chronaxia of the eye. A flash of light of the speed of 2×10^{-7} seconds was still seen by the eye. This is far more rapid than the figure presented by workers on chronaxia. My own work,[46] while not entirely linked with the subject of chronaxia, also raises doubt, as a light of the magnitude of one thirty-three-thousandth of a second was easily seen by the nearer periphery of the retina. Further work along this line to be reported soon will show that even a flash of one one-hundred-thousandth of a second is perceived by the fovea.

From the standpoint of ophthalmology it is interesting to note that shutting off the visual sense increases irritability. Altenburger sees herein a possible explanation for the astonishing increase in the functional capacity of the blind. Light of short wavelengths also changes the sensory chronaxia, and so do baths, galvanization, etc.; these changes in the chronaxia are probably partly responsible for the effects of these much used factors in physical therapy.

CONCLUSIONS

This presentation, which is intended to give the ophthalmologist an insight into the doctrine of chronaxia, is necessarily long and involved, and yet many of the experimental phases have only been touched on,

43. Grijns, G., and Noyons, A. K.: Ueber die absolute Empfindlichkeit des Auges für Licht, Arch. f. d. ges. Physiol., 1905, p. 25.

44. Stein, J.: Handbuch der Geisteskrankheiten, Berlin, Julius Springer, 1928, vol. 1, p. 352.

45. Poole, J. H. J.: An Attempt to Determine Whether a Minimum Time is Necessary to Excite the Human Retina, Phil. Mag. **43**:345, 1922.

46. Mayer, L. L.: Visual Fields with Minimal Light Stimulus, Arch. Ophth. **9**:353 (March) 1933.

and others, because of the number, have had to be neglected, or omitted entirely. No claim of completeness is made, but, at least, some insight into the performance and manner of function of the visual apparatus may be gained by a study of the doctrine of chronaxia. The anticipated fruitfulness of future research work may well be realized, and the possible practical clinical importance may be visualized. Further work must show how far a determination of the time value can be built up to a quantitative method of practical differential diagnosis of organic lesions of the eye itself and of the optic pathways.

104 South Michigan Avenue.

News and Notes

SOCIETY NEWS

Chicago Ophthalmological Society.—The annual meeting of the Chicago Ophthalmological Society was held in Chicago on January 28. Dr. Arnold Knapp, the guest of honor, spoke on "The Surgical Treatment of Retinal Detachment." The following officers were elected: Dr. Robert Blue, president; Dr. Earle Fowler, vice-president, and Dr. Thomas Allen, secretary and treasurer.

Philadelphia County Medical Society, Eye Section.—The program for the January 3 meeting of the Eye Section of the Philadelphia County Medical Society was as follows:

"A Typical Case of Retinitis Proliferans," Dr. J. M. Rosenthal; "A Case of Conical Cornea Wearing Contact Lenses," Dr. Charles W. Le Fever; "Lacrimal Cases," Dr. C. E. G. Shannon and Dr. Carroll Mullen, and "Applied Anatomy and Physiology of the Naso-Lacrimal Apparatus, with Lantern Slide Demonstration," Dr. J. Parsons Schaeffer.

CORRECTION

In Dr. M. Davidson's discussion of the paper by Dr. James Watson White, entitled, "Routine Examination of Muscles in Practice," in the Transactions of the Section on Ophthalmology of the American Medical Association, published in the December issue (ARCH. OPHTH. **12**:970, 1934), on page 984, line 16, "total hyperphoria" should read "total hyperopia"; line 17, "hypertropia" and "hyperphoria" should read "heterotropia" and "heterophoria," respectively; line 19, "multiplication" should be "modification;" line 26, "no binocular defect" should read "no binocular stereopsis;" lines 28 and 29, "contrasting color" should read "test object," and line 31, "against" should be changed to "before."

Abstracts from Current Literature

EDITED BY DR. WILLIAM ZENTMAYER

Anatomy and Embryology

THE NERVES OF THE TUNICS OF THE EYE. I. ERNYEI, Arch. f. Ophth. **132:** 14 (March) 1934.

Ernyei studied the histology of the nerves in the eyes of dogs, cats, pigs, sheep, horses, cattle and rabbits. He used the silver impregnation method of Bielschowsky and a prolonged osmium staining method after Kiss. He found no ganglion cells. In the choroid the nonmedullated fibers prevailed, while in the sclera the medullated ones were in the majority. The latter were also very numerous in the ciliary body. In the ciliary processes, however, only nonmedullated fibers were found. Some corneal nerves kept their sheaths for some distance into the cornea.

P. C. KRONFELD.

THE DEVELOPMENT OF THE ANTERIOR CHAMBER IN MAN. A. GLÜCKSMANN, Arch. f. Ophth. **132:** 51 (March) 1934.

Glücksmann gives new evidence for a view on the development of the anterior chamber which he published first in 1929 (*Ztschr. f. d. ges. Anat.* [Abt. I] **88:** 529 1929). According to this view the anterior chamber develops through the separation of two well differentiated layers of mesoderm. Those two layers are formed in close relation to the other mesodermal parts of the eye. The time of their differentiation depends on their respective distance from the ectodermal layers of the eye. The choroid is first, then follow the sclera, the periocular connective tissue and finally Tenon's capsule. The same sequence applies to the growth of the mesodermal tunics into the space between the ectoderm and the lens vesicle. The anlage of the choroid forms the pupillary membrane, the prospective sclera, the corneal endothelium and so on. The paper is accompanied by good photomicrographs of well preserved embryos. Considerable space is devoted to refuting Fischer's view (*Arch f. Ophth.* **126:** 504, 1931) as well as those of Seefelder, Ida Mann and others.

P. C. KRONFELD.

Aqueous Humor

THE OXIDATION-REDUCTION POTENTIAL OF THE AQUEOUS HUMOR IN THE NORMAL AND THE CATARACTOUS EYE. J. NORDMANN and P. REISS, Compt. rend Soc. de biol. **116:** 223, 1934.

Potentials were secured in animals and man by introducing a platinum electrode through the cornea. The average value in the normal rabbit and the normal guinea-pig was + 127 millivolts. In rabbits with naphthalinic cataract the potential reached + 193 millivolts. The increase of potential precedes the slightest apparent change in the lens.

In man the potential was measured in blind eyes in which the lens was not involved (optic atrophy, choked disk) and in these cases averaged + 185 millivolts. In cataract, however, the potential averaged + 205 millivolts.

J. E. LEBENSOHN.

Bacteriology and Serology

THE INJECTION OF ANTHRAX BACILLI THROUGH THE CONJUNCTIVAL SAC. M. AÏTOFF, Compt. rend. Soc. de biol. **115:** 21, 1934.

The conjunctival mucosa, which is sensitive to vaccinal virus and to the bacilli of tuberculosis and of plague, provides an impassable barrier to the anthrax bacillus. An emulsion of billions of anthrax bacilli may be deposited in the conjunctival sac of a guinea-pig with impunity and remain there for as long as seven days without affecting the health of the animal. A previous superficial ulceration of the cornea or thermal cauterization of it does not interfere with the immunity. However, when on the third day of the experiment the inferior culdesac was pricked deeply with a sterile needle, two of the four guinea-pigs succumbed to anthrax septicemia. This confirms Besredka's observation that the anthrax bacillus is not pathogenic unless a solution of continuity is present.

J. E. LEBENSOHN.

INOCULATION OF STÉFANSKY'S BACILLUS [B. LEPRAE] INTO THE ANTERIOR CHAMBER OF THE RAT'S EYE. V. CHORINE, R. GUILLINY and E. MONTESTRUC, Compt. rend. Soc. de biol. **116:** 1261, 1934.

On inoculation of Stéfansky's bacillus into the anterior chamber of the rat's eye the following observations were made over a period of fourteen months: (1) A leproma developed which had its origin in the ciliary processes, and which extended to the iris, anterior part of the choroid and sclera; (2) the infection then passed from the globe to the submaxillary ganglions, which opposed a temporary barrier to its spread; (3) the brain and meninges were not invaded.

J. E. LEBENSOHN.

THE BACTERIA IN THE INFLAMED AND IN THE NORMAL CONJUNCTIVA AND THEIR EVALUATION. G. FODOR and L. VLASITS, Klin. Monatsbl. f. Augenh. **92:** 643 (May) 1934.

Fodor and Vlasits evaluate the bacterial flora of the conjunctival sac, premising that some isolated pneumococci in acute conjunctivitis may not cause the condition, hence may not be of any consequence. Their presence, on the other hand, in the conjunctival sac of a patient ready to undergo an intra-ocular operation may be of utmost importance. The authors discuss and compare their methods of examination with those of other bacteriologists and illustrate the experimental results by means of tables. Granting that the eye is a proper object for local serotherapy, they demonstrate by a table that group IV of the pneumococci is prevalent in ophthalmic conditions, according to the research of six writers. The pneumococci of group II found by Wamoscher and by Jahnke in serpiginous ulcer of the cornea were benign. The corneal ulcers healed without cauterization. Pneumococci of groups I and II

were found on the normal conjunctiva. The authors found (1) that staphylococci and streptococci do not cause conjunctivitis; (2) pneumococci of group IV are usually found in the normal conjunctiva, in some acute conjunctivitides, in serpiginous ulcer of the cornea, in acute and chronic dacryocystitis, in panophthalmitis following serpiginous ulcer and in postoperative infections; (3) the pneumococci belonging to group IV act like saprophytes on the epithelium of the conjunctiva and cornea; (4) only those conjunctivitides may be considered as caused by pneumococci which take a characteristic and severe clinical course and in which pneumococci are present abundantly and almost as a pure culture; (5) pneumococci of groups I and II are causing these inflammations; (6) no result based on scientific considerations can be expected in ophthalmic disorders by serotherapy, because the pneumococci present belong mostly to group IV.

K. L. STOLL.

Conjunctiva

OCULAR MANIFESTATIONS RESEMBLING THE BULLOUS ERUPTIONS OF THE POLYMORPHIC DERMATITIS OF DUHRING and BROCQ. A. KOUTSEFF, Bull. Soc. d'opht. de Paris, March 1934, p. 170.

Koutseff reports a case of an unusual conjunctival involvement following a rare condition of the skin. A man, 53 years old, whose ancestry was not marked by any relative condition, noted an eruption on the skin of the hands and left instep. The eruption was preceded by intense pruritus. After the cutaneous vesicles had broken and their liquid contents had been discharged, the itching subsided. This condition was called "eczema" and was treated as such. Four years later a symmetrical eruption occurred on the face, and the temporal regions were especially involved. At the onset there was marked itching, which disappeared promptly at the moment of eruption. After an interval of three years the lips and the pharynx were involved in turn. In the same year the eyes were red and inflamed for two months. The onset of the latter condition was marked by a burning sensation. No bullae were noted, but the pain was continuous. Two months after the onset the lower lids presented a cicatricial entropion. The conjunctivae were covered with a pseudomembrane, and a number of small bands connected the bulbar and palpebral conjunctivae. At the internal angle, the conjunctiva had undergone dry keratinization. The corneas were clear and transparent and showed no pannus formation. Vision was normal. Bacteriologic examination revealed the hemolytic Staphylococcus albus, Staphylococcus aureus and the pseudodiphtheria bacillus. The results of the general examinations were within normal limits. Duhring and Brocq described a similar condition of the skin as characterized by: (1) polymorphism of the eruption, (2) pain of variable intensity, (3) habitual conservation of a good general status and (4) a tendency to relapse.

The term "pemphigus" is reserved for a progressive bullous condition, which is rare but always fatal. The only other case of this kind reported was one observed by Redslob. Vitamins, sulpharsphen-

amine and collyria had no effect in the treatment. The ocular prognosis must be reserved, for this case terminated in complete blindness.

L. L. MAYER.

ERYTHEMA NODOSUM AND PHLYCTENULAR CONJUNCTIVITIS. NOBÉCOURT and DUCAS, Presse méd. **42**: 1241 (Aug. 4) 1934.

The finding of erythema nodosum and phlyctenular conjunctivitis in the same subject is rare. As both lesions usually have a tuberculous origin the report becomes of greater interest.

An 11 year old girl was seized with fever, headache, fatigue and anorexia. In four days an eruption characterized by violet and red papules appeared on the lower extremities and was confined there throughout the attack. The nodules were from 2 to 3 cm. in diameter and appeared in groups of seven or eight. They were slightly mobile, presented a prominent center and an indecisive periphery, and appeared set in the skin surface. Certain of the lesions were new, appearing as ecchymotic spots; others were old and seemed about to disappear. Physical examination and the x-ray picture of the lungs showed definite evidence of pathologic changes at the hilus. The father had died of tuberculosis. One month after the child entered the hospital, a lesion appeared on the conjunctiva of the left inferior lid. The ophthalmologic consultant, not knowing of the patient's general condition, pronounced the palpebral condition phlyctenular conjunctivitis. A tuberculin test was positive. Guinea-pigs inoculated with the patient's blood showed tubercle bacilli in the inguinal glands at autopsy. The authors are inclined to agree with the statement of Fornara that such lesions become apparent when the patient is in a hyperallergic state. A chart, x-ray picture and bibliography are given. L. L. MAYER.

KOCH-WEEKS CONJUNCTIVITIS. H. SCHMELZER and E. ECKSTEIN, Arch. f. Ophth. **132**: 20 (March) 1934.

A small epidemic of Koch-Weeks conjunctivitis broke out in Erlangen (Bavaria) in the summer of 1930. In forty-two of fifty-eight cases the micro-organisms were demonstrated in smears and cultures; in six other cases they were present only in the cultures. No patient had any accompanying infection of the upper respiratory tract or general disease of any kind. The organisms found were always of the so-called type II (small slender gram-negative bacilli) of the Koch-Weeks and Pfeiffer group (Knorr: *Ergebn. d. Hyg., Bakt., Immunitätsforsch. u exper. Therap.* **6**: 350, 1923). Thirty-four strains were tested for pathogenicity for mice. It was found that even very big doses (up to 12 loops) of thirty of thirty-four strains were well tolerated intraperitoneally by mice. The remaining four strains were pathogenic in large doses. Intraperitoneal inoculations of conjunctival secretion taken directly from patients' eyes were also tolerated in seven of seven mice. The lack of pathogenicity of the organism for mice and the absence of infections of the upper respiratory tract in the patients are stressed as strong arguments in favor of the basic difference between the Pfeiffer and the Koch-Weeks bacillus.

P. C. KRONFELD.

Comparative Ophthalmology

OCULAR TROUBLES IN GALLINACES' PARALYSIS. MORAX, TRUCHE and NIDA, Ann. d'ocul. **171:** 385, 1934.

The ocular lesions observed in chickens suffering from paralysis consisted of an inflammation of the iris and ciliary processes, recognized macroscopically by the depigmentation of the iris and a contracted, irregular pupil. The iridocyclitis consisted of chronic inflammation with diffuse infiltration by mononuclears, plasma cells and lymphocytes. The inflammation may cause secondary trouble in the cornea and lens. In the former there is edema giving the appearance of an interstitial keratitis. This is present from the onset of the disease. On the surface of the lens the changes are similar to those seen in man, particularly those in the child with an infectious iridocyclitis (syphilis, tuberculosis).

In the first chicken, in which the two lenses were affected, there was not found any lesion of the choroid or retina. S. H. MCKEE.

OCULAR COMPLICATIONS OF LYMPHADENITIS OF THE DOG. V. ROBIN and A. BRION, Bull. Soc. d'opht. de Paris, April 1934, p. 238.

A generalized lymphadenitis in the dog is compared to the disease in man known as chronic pseudoleukemia or aleukemic lymphomatosis. The ocular complications consist of a mild buphthalmos, congested conjunctiva and an annular gray opacity of the cornea with new vessels entering and branching greatly. The pupil is contracted; the entire anterior chamber is diffusely red, and there is an abundant hyphemia. Veterinarians have believed the condition is due to an infection, but no organism has been demonstrated. Others think that tuberculosis affecting the reticulo-endothelium may be responsible. L. L. MAYER.

MELANIN, VISUAL PURPLE AND THE VISUAL CELLS. M. L. VERRIER, Compt. rend. Soc. de biol. **115:** 1590, 1934.

In an extensive comparative study that included various fish, frogs and albino mice, Verrier found that the content of visual purple in the retina ran parallel to the amount of melanin in the pigmentary epithelium. Albino mice, though possessing long, fine rods, are entirely without visual purple. If the rods are essential in the production of visual purple, they evidently play but a subordinate rôle.

J. E. LEBENSOHN.

REGIONAL VARIATIONS IN THE ARRANGEMENT OF THE HORIZONTAL CELLS IN THE RETINA. Y. UYAMA, Arch. f. Ophth. **132:** 10 (March) 1934.

The eyes of young cats were enucleated under chloroform anesthesia, opened by equatorial section, the vitreous removed and the retina cut in small sector-shaped pieces. These were directly impregnated with silver nitrate, then treated with pyrogallic acid and solution of formaldehyde, embedded in paraffin and sectioned parallel to the inner surface. The photomicrographs show that the horizontal cells in areas temporal or nasal to the disk are better developed than those in more peripheral areas.

P. C. KRONFELD.

Congenital Anomalies

ABNORMAL ANLAGE OF THE CILIARY BODY IN A MICROPHTHALMIC EYE. F. FISCHER, Arch. f. Ophth. **132:** 71 (March) 1934.

One of the two microphthalmic eyes removed from a child at autopsy showed the following very unusual changes: The globe had a sagittal diameter of 5 mm. The cornea, anterior chamber, iris, pupil, ciliary body and lens were absent. The entrance of the optic nerve was very wide and filled up with glial and mesodermal tissue and with nerve fibers. The optic nerve itself was very thin. Around its entrance into the globe lay an extensive coloboma. There the pigmented epithelium was absent, and the choroid was very thin and carried only very few vessels. The retina was present as a double but severely changed layer. Outside of the colobomatous area the choroid and pigmented epithelium were normal. The coloboma was bordered on its lateral side by an anlage of the ciliary body located in the posterior segment, which contained numerous well formed processes. Fischer discusses the probable mechanism of this unusual malformation.

P. C. KRONFELD.

THE RELATION BETWEEN MICROPHTHALMUS WITH CYST OF THE LOWER LID AND GENERAL MALFORMATIONS. E. VON HIPPEL, Arch. f. Ophth. **132:** 256 (April) 1934.

Von Hippel had the opportunity to examine four specimens showing extensive general malformations which were the property of the Pathological Institute of the University of Göttingen. In all four cases both orbits with their contents could be studied anatomically. The bulbi were all microphthalmic and communicated with typical cysts of the lower lid. The fact that in these four cases and in others reported in the literature large congenital cysts were found in the brain, kidney, pancreas and liver made the author think of a relation between microphthalmus and the complex of symptoms of Lindau. Besides, he found in one of the four cases a capillary angioma in the retina. Other interesting findings in the microphthalmic eyes were extensive cystic degeneration of the retina and entropion iridis.

P. C. KRONFELD.

Cornea and Sclera

WHITE RINGS IN THE CORNEA. H. B. STALLARD, Brit. J. Ophth. **18:** 452 (Aug.) 1934.

The patient was a boy aged 17. There was no history of corneal ulceration; a lotion or drops containing lead salts had never been used. The eyes were normal except for a minute broken oval ring of white dots approximately 2 by 0.15 mm. situated in the upper temporal quadrant of the right cornea about 2 mm. inside the limbus. In the oval center there were some white spots of irregular size and shape. They resembled spots of white lead paint and were superficial to Bowman's membrane. The overlying corneal epithelium was smooth. There was no evidence of any pathologic disturbance in the surrounding cornea.

Details of similar cases are to be found in an article by Ballantyne (Brit. J. Ohpth. **17:** 336 [June] 1933; abstr., ARCH. OPHTH. **12:** 107 [July] 1934).

The article is illustrated.

W. ZENTMAYER.

BLUE SCLERAE AND FRAGILITAS OSSIUM. J. CASANOVAS, Arch. de oftal. hispano-am. **34:** 133 (March) 1934.

After a brief review of the literature on the relation between blue sclerae and fragilitas ossium and of the theories presented on the causation of fragilitas ossium and on the influence of heredity, Casanovas reports a case in a male child, 9 months old, with no antecedents from whom he might have inherited the condition and with four brothers in whom the lesions were absent. This child was born at term after a normal labor. He was very poorly nourished and had been fed first on condensed milk, next on cow's milk and finally on some farinaceous milk food. The sclerae were very blue, and the bones of the cranium were excessively thin, with open, communicating fontanels. There was also clinical and roentgenographic evidence of consolidated fractures of the right clavicle, of four ribs on the right side and two on the left, of the two humeri (double on the right side), of the left ulna and radius, of the two femurs (double on the left side) and of the left tibia. The child having died of a gastro-intestinal complaint, an anatomicopathologic examination of both eyes was made, which showed only excessively thin sclerae and marked uveal pigmentation, to which the blue color of the sclerae can be attributed.

C. E. FINLAY.

FURTHER DATA ON CORNEAL TRANSPLANTATION. V. P. FILATOV and S. L. WELTER, Sovet. vestnik oftal. **4:** 6, 1934.

At the Odessa (Russia) Eye Clinic during the years from 1922 to 1932 partial penetrating corneal transplantation was performed in ninety-six cases. Forty-eight were not considered proper cases, as they were complicated by buphthalmos, glaucoma, ectasia of the leukoma, etc. In fourteen of the remaining forty cases or 29.5 per cent, the transplant remained transparent during the time of observation (a few patients were observed for six years). All the successful operations were on corneas which contained some transparent corneal elements.

Filatov and Welter report five additional successful keratoplastic operations for the year 1933, which bring the good results up to 36.5 per cent. In all five patients the "taking" of the transplant can be considered permanent, as they were observed for from eleven to thirteen months. The operation in each case is described in detail. In three patients Filatov's conjunctival flap was used for keeping the transplant in place; in two, an egg membrane with Elshnig's sutures over it was applied for the same purpose. In two patients the prophylactic ivory plate was used in the anterior chamber during the operation. In three patients in whom the cornea was opaque because of interstitial keratitis the results were perfect, as the vision improved from 2/60, 5/60, 2/60 to 0.7, 0.4 and 0.2 respectively. The authors ascribe the favorable results to the presence of transparent corneal

elements. The fourth patient had a diffusely opaque cornea, the result of an acid burn. The vision improved from 1/60 to 0.1. In the fifth patient the transplant was transparent, but the vision improved only slightly because of a thick connective tissue membrane which formed behind the transplant. Two transplants were taken from eyes with carcinoma of the orbit, two from eyes showing absolute glaucoma with transparent cornea, and one from an injured eye.

O. SITCHEVSKA.

GUMMA OF THE SCLERA. F. P. GOLDBERG, Sovet. vestnik oftal. **4:** 76, 1934.

About fifty-two cases of gumma of the sclera have been reported. Of these, thirteen were observed in Russia. Goldberg's patient, aged 19, complained of redness and discomfort in the right eye. Four months previously he had "ulcers" on one arm and one leg. The Wassermann reaction was 4 plus. The conjunctiva of the right eye was edematous. On the temporal side near the limbus, it covered a dome-shaped, violet-colored elevation of the sclera about 4 mm. above the cornea. The cornea adjacent to the elevation was opaque, with numerous superficial blood vessels. Six weeks after the antisyphilitic treatment was started the tumor of the sclera was flattened, the corneal opacity had cleared up, and the conjunctival congestion had disappeared. The differential diagnosis, which is discussed, confirms the diagnosis of gumma of the sclera.

O. SITCHEVSKA.

USE OF THE CORNEA FROM A CADAVER FOR TRANSPLANTATION. V. P. FILATOV, Sovet. vestnik oftal. **4:** 223, 1934.

Filatov discusses the possibility of the conservation and use of the cadaver's eyes for corneal transplantation. The most important problem is to keep the cornea within a balanced temperature, not above 4 to 6 C. Since, according to the law, the eye cannot be enucleated before two hours after death, the temperature is too high for the cornea while it is in the ward; then it is changed during transportation to the morgue and again while in the morgue.

Filatov reports a case in which he used the cornea of a cadaver's eye enucleated forty-one hours after death. The eye was kept thereafter for a few hours in the ice-chest at 4 C. At the time of the operation the cornea was slightly opaque over the whole surface. The patient had been blind for eighteen years owing to an infection from varicella. The right eye had nystagmus and a dense leukoma, but the light projection was fairly good. The transplant from the cadaver "took" well and remained transparent for fourteen months, the period of observation. The pupil was seen; there was an annular posterior synechia adherent to the cataractous lens. Filatov believes that in principle the cadaver's cornea can be used for corneal transplantation. Since there is an increased demand for this operation with the improvement of the technic and with the spreading of information among the blind, the material for corneal transplants must also be increased in quantity.

O. SITCHEVSKA.

Experimental Pathology

THE METABOLISM OF NAPHTHALENE IN RABBITS. M. C. BOURNE and L. YOUNG, Biochem. J. **28**: 803, 1934.

Naphthalene is detoxicated in the rabbit partly by conjugation with cysteine and in this combination is excreted as mercapturic acid. The cataract which naphthalene produces may result from the lens being deprived of cysteine.

J. E. LEBENSOHN.

NOXIOUS EFFECTS OF HEAT ON THE EYE. W. HOFFMANN and E. KUNZ, Arch. f. Ophth. **132**: 155 (April) 1934.

Heat was applied to the eyes of rabbits in two ways. In the first series of experiments the eyeball was luxated in front of the palpebral fissure and immersed in running water of a temperature of 47 to 80 C. Thus the heat was transmitted to the deeper structures by conduction. In the second series diathermy was used, with careful elimination of any effect of heat at the place where the electrode was applied. In both series the temperature inside the eye was measured by means of thermocouples introduced into the anterior chamber, lens or vitreous. The eyes thus treated were enucleated at intervals varying from a few minutes to several months after the operation.

Visible damage occurred if the temperature inside the eye had been above 45 C. In the lens the subcapsular layer of fibers was destroyed. The thickness of this layer depended on the amount of heat applied. The "heat cataract" was morphologically different from the "fire cataract." The changes in the other tissues were chiefly circulatory in nature. The vessels were usually very much dilated, and hemorrhages and exudation into the tissues and preformed clefts occurred. The epithelial tissues were found to be more sensitive to heat than the connective tissue.

P. C. KRONFELD.

ACTION OF RADIATION ON THE RABBIT'S EYE. S. M. CHAYUTIN, Sovet. vestnik oftal. **5**: 477, 1934.

Sixteen rabbits' eyes were subjected to prolonged radiation; the source of the energy was a one-half watt lamp of from 250 to 500 volts, the distance from the eye being from 10 to 20 cm. The rabbits were irradiated daily for from six to eight hours in special chambers for periods of from twelve to twenty months. The media were examined weekly with the corneal microscope.

Chayutin observed changes in the lens in the shape of punctate and striped opacities in all layers, also in the posterior capsule of the lens. The changes were demonstrated at first by the slit lamp and later on with only focal illumination. Ophthalmoscopic examination of the fundi revealed in albinos enlarged retinal vessels and punctate hemorrhages, while in the pigmented rabbits an edematous retina with circumscribed chorioretinal lesions was observed.

O. SITCHEVSKA.

General

ELECTROLYTIC SENSITIVITY. E. MARCHESINI, Arch. di ottal. **40:** 114 (March) 1933.

Marchesini discusses the severe pain suffered by some persons during electrolysis of cilia, which is not prevented by cocainization. The pain is not felt during introduction of the needle, but only when the circuit is closed. Besides 5 per cent cocaine, procaine hydrochloride, benzoyldimethylaminomethylpropanol, bulocaine, alypin, phenacaine, nupercaine and *p-n*-butylaminobenzoyl-dimethylamino-ethanol hydrochloride were used in corresponding concentrations, also 50 per cent alcohol, 1 per cent phenol and 5 per cent quinine and urea hydrochloride. Amounts of from 3 to 6 cc. were injected, resulting usually in complete tactile and thermal anesthesia and anesthesia of the pain sense provoked by needle puncture. The pain when the circuit was closed, however, was unaffected or only slightly diminished. The same observation was made when nerve-blocking was carried out with 2 per cent cocaine, which excluded the possibility that the sensation was transmitted beyond the anesthetized zone. To exclude the possibility that the positive pole held between the hands was the source of pain, the two poles were placed within the anesthetized zone, but the painful sensation on closing the circuit persisted. The pain was always referred to the region of the negative pole. The possibility that the anesthetic was so changed in composition by electrolysis as to lose its anesthetic properties was excluded by the demonstration that anesthesia to other stimuli persisted after electrolysis. Other possibilities, such as the effect of positive ions accumulating at the negative pole, could also be excluded. Section of the sensory nerve trunk to a given region in the rabbit did abolish pain from electric stimuli.

S. R. GIFFORD.

General Diseases

VALUE OF EYE SYMPTOMS IN THE DIAGNOSIS OF GENERAL DISEASES. HAROLD G. A. GJESSING, Brit. M. J. **1:** 567 (March 31) 1934.

In Gjessing's opinion, the new diagnostic triad for multiple sclerosis should be: (1) pronounced fatigue following insignificant body exercises and accentuation of symptoms already present, (2) increase in the tendon reflexes and (3) passing eye symptoms, frequently with a tendency to recurrence. Acute scotomatous retrobulbar neuritis is the most important eye symptom in this disease, occurring in about 50 per cent of all cases. Transient palsies of the ocular muscles occur in from 25 to 45 per cent of cases.

In syphilis, ptosis, nystagmus and various pupillary changes are of importance. A paralysis of the reaction to light and accommodation may follow diphtheria or may be the sign of beginning meningitis. Cyclitis is not uncommon after influenza. Conjunctivitis accompanies many of the acute infectious diseases. Botulism, meat poisoning, gastro-enteritis and paratyphoid fever may be followed by complete or incomplete ophthalmoplegia.

The sudden appearance of myopia (or decrease in hyperopia) often indicates the presence of diabetes. Most glaucomatous patients have

either a diseased circulatory system, or an imbalance between the sympathetic and parasympathetic nervous system or both.

In cases of hemorrhagic diathesis, congenital or acquired, there is a tendency to bleed into the external as well as into the internal parts of the eye.

Both diabetes and nephritis are marked by retinal hemorrhages and exudates which are of diagnostic and prognostic significance. Since an albuminuric neuroretinitis may simulate the choked disk of cerebral tumor, a careful functional examination is important, because, with choked disk, the vision, to begin with, is less reduced than would be expected in view of the pronounced ophthalmoscopic picture. Also, optic neuritis must never be taken for a *morbus sui generis*.

Poisoning due to substances such as santonin, methyl alcohol, digitalis, lead or quinine is not rare, and if a careful history and field are taken, the cause will often be discovered.

Among the deficiency diseases, night blindness, xerosis of the conjunctiva and keratomalacia are prominent findings.

Among miscellaneous conditions, Gjessing mentions that amenorrhea without any physiologic reason or an early impotence may be due to trouble in the region of the hypophysis.

W. F. DUGGAN.

THE RELATIONSHIP BETWEEN VARICELLA AND HERPES ZOSTER. G. RENARD and P. HALBRON, Arch. d'opht. **51**: 151 (March) 1934.

After presenting the arguments for and against the identity of varicella and herpes zoster Renard and Halbron describe a personal observation which lends support to the hypothesis of a common origin. A boy, 6½ years old, was admitted to the hospital because of a penetrating wound of the cornea. He was allowed to be up and about the ward as soon as he was well enough. The day after his entrance a man was admitted with typical herpes zoster ophthalmicus. Two days later this man presented an eruption of the skin which it was thought might be varicella or a generalized herpes. The boy, eighteen days after his admission, presented typical varicella. No history of varicella in the immediate family or among the neighbors was obtainable. The boy was the only patient of his age in the ward. These observations make it appear that the man with herpes zoster had a herpetic eruption or varicella fourteen days (the normal period of incubation) prior to the development of varicella in the boy.

S. B. MARLOW.

ALLERGIC DISTURBANCES OF THE EYE. J. URBANEK, Wien. med Wchnschr. **47**: 533 (April 27) 1934.

Urbanek is satisfied that because tubercle bacilli are frequently demonstrable in disease of the eye, especially in uveitis, tuberculosis may well be held responsible for other pathologic conditions of the eye. Meller was able to demonstrate a tubercle bacteremia in a number of cases of keratoconjunctivitis. It is most likely that the uncleanliness of the skin found in the majority of cases of keratoconjunctivitis allows the exogenous noxa to enter the conjunctival sac. A second endogenous or exogenous factor is necessary in addition to the sensitivity of the

organism. Therefore, besides tuberculin allergy, an unknown factor must exist to cause a scrofulous keratoconjunctivitis, and the local exogenous component is the most likely. Following the war fully 40 per cent of eye disorders could be classified as scrofulous. Nearly all these patients had skin disorders. Often it has been noted that when one eye with a tuberculous disease is treated with tuberculoprotein, the other eye becomes diseased. The allergic disturbances of the eye seem to be entirely on a tuberculous basis.

L. L. MAYER.

Glaucoma

THE CLINICAL USE OF THE NEW MIOTIC CABRAMINOYLCHOLINE IN THE TREATMENT OF GLAUCOMA. K. VELHAGEN, Klin. Monatsbl. f. Augenh. **92:** 472 (April) 1934.

Velhagen used carbaminoylcholine as a miotic in glaucoma at the University Eye Hospital of Halle, Germany, for nearly two years. In a former report he described the chemical composition and the action of this drug (*Klin. Monatsbl. f. Augenh.* **90:** 512 [April] 1933; abstr., ARCH. OPHTH. **11:** 1071 [June] 1934). A detailed report on Velhagen's experiments with this miotic appeared in the *Archiv für Augenheilkunde* (**107:** 319, 1933).

This remedy may show its usefulness at a later date in the treatment of diseases of the arteries. In the present paper Velhagen demonstrates the merits of the new miotic in the treatment of glaucoma by means of tables and histories of cases. It lowered the intra-ocular tension in all cases except four of absolute glaucoma. No result was obtained in a case of secondary glaucoma and aphakia. It was not used in inflammatory glaucoma and hydrophthalmos. Instant decrease of the intra-ocular tension and instant ceasing of glaucomatous headache were noticed in simple chronic glaucoma. A 0.75 per cent solution of carbaminoylcholine (doryl) is superior to a 1 per cent solution, and in some cases to a 2 per cent solution of pilocarpine, and it acts more promptly than a 0.5 per cent solution of physostigmine. No local disturbances were noted, but there was occasional headache lasting for two hours after instillation. The nausea and difficulty in swallowing which are observed after the use of physostigmine were absent. Carbaminoylcholine is supposedly a powerful poison in the digestive tract and it is sold, therefore, only in 5 cc. bottles of a 0.75 per cent solution. Atropine is an antidote. No accidents have occurred, and instillation into both eyes twice or three times a day was found to be free from poisonous effects.

K. L. STOLL.

RARE OCCURRENCES AFTER ELLIOT'S TREPHINING: A. CONTRIBUTION ON PARENCHYMATOUS KERATITIS AND TRAUMA; REPORT OF CASES. F. SCHULMANN, Klin. Monatsbl. f. Augenh. **92:** 522 (April) 1934.

Three cases are reported of rare occurrences following trephining after Elliot. In the first case, that of a woman, aged 20, recurrence of congenital parenchymatous keratitis four years after the primary inflammation was attributed to the trauma produced by trephining. The

frequency of recurrences of parenchymatous keratitis is discussed, and trauma is made responsible in a larger number of cases than has hitherto been suspected.

Anterior and posterior synechiae followed trephining of an eye in which the tension remained very low and the anterior chamber did not reestablish itself. Recovery was obtained after regulation of the tension and separation of the synechiae.

Acute plastic iridocyclitis, probably noninfectious, followed trephining in the third case. A perfectly transparent exudation formed in the pupil and vascularized quickly. The complications in the second and third cases were attributed to the fact that the glaucomas were not of the chronic simple type, but were transitional to the chronic inflammatory type. In such cases Schulmann recommends iridectomy, and trephining only in case the iridectomy should fail.

Relative to suturing of the conjunctival flap, he thinks that an inaccurate suture may lead to formation of a fistula and retardation of healing. A suture may be dispensed with if the flap is properly replaced.

K. L. STOLL.

KYESTEIN IN GLAUCOMA. A. STARODUBTZEVA, Sovet. vestnik oftal. **5:** 30, 1934.

Starodubtzeva used kyestein (purified urine of pregnant women) parenterally in thirty-three glaucomatous patients (forty-seven eyes), aged from 48 to 72 years. The duration of their disease was from one to fifteen years. Kyestein was applied on the following grounds: 1. Glaucoma develops mostly in elderly people in whom the functioning of the endocrine gland system is considerably lowered. 2. The function of the ciliary body is possibly that of an endocrine gland influencing the intra-ocular metabolism. 3. Since the cause of glaucoma may be manifold, kyestein can be used because of its complex hormone content.

In twenty-five patients kyestein was combined with miotics; in eight patients it was used alone. There was improvement of the general condition in twenty-eight patients. In fifteen of these the visual acuity was improved from 0.1 to 0.5, the visual field was enlarged from 10 to 40 degrees, and the tension was decreased by from 5 to 30 mm.

Starodubtzeva comes to these conclusions: 1. Kyestein is nontoxic. 2. It acts as a general tonic, and it regulates the blood pressure. 3. In many cases it lowers the intra-ocular tension. 4. It relieves pain and inflammation. 5. It acts like a tonic on the elements of the optic nerve. 6. More experience with kyestein in diseases of the eye is necessary in order that these data may be confirmed.

O. SITCHEVSKA.

MODIFICATION OF THE CONJUNCTIVAL FLAP IN ELLIOT'S OPERATION. A. Y. SAMOILOFF, Sovet. vestnik oftal. **5:** 66, 1934.

In performing the Elliot operation, Samoiloff makes the incision for the flap horizontal to, instead of concentric with, the limbus. A very superficial separation of the conjunctiva is made at the beginning, and

it is deepened near the limbus. These two steps prevent the displacement of the flap and make sutures unnecessary; that is, a possible infection is prevented.

O. SITCHEVSKA.

Instruments

A NEW CONJUNCTIVAL-FOLD FIXATION FORCEPS. D. S. STEWART, Brit. J. Ophth. **18:** 274 (May) 1934.

Each limb of the forceps consists of a curved foot fixed at an angle to the shank. At the heel and toe of this curved foot are 2 by 1 mouse teeth, the inner faces of the intermediate portion being slightly serrated. In use the forceps is applied to the eyeball with the jaws open so that the teeth engage with a fold of conjunctiva about 8 mm. wide, which rises between the jaws and is held there when the forceps closes. For convenience in handing to an assistant a spring catch is fitted. Stewart uses the forceps principally for iridencleisis.

The article is illustrated.

W. ZENTMAYER.

Lacrimal Apparatus

AN ATTEMPT TO CLASSIFY THE DIFFERENT VARIETIES OF TEARING AND THE METHODS OF OCULONASAL SURGERY. H. TILLÉ, Bull. Soc. d'opht. de Paris, April 1934, p. 247.

The conclusions are as follows: 1. In a series of sixty-six patients with tearing the most important were those due to nasal defects, which are best treated by the rhinologist.

2. Tearing due to associated lesions of the lacrimal canal and the inferior meatus is cured in all cases in three weeks by the mixed treatment (one or two catheterizations, with or without associated stricturotomy and luxation of the inferior horn of the meatus). Exceptionally it is necessary to remove the sac.

3. Tearing without apparent stenosis is much less frequent than other types. It is best treated by injection of alcohol into the lacrimal nerve or diathermic coagulation of the lacrimal gland.

4. Tearing due to obstruction of the canal alone is cured by one or two catheterizations with a no. 2 or 3 sound.

5. For purulent dacryocystitis removal of the sac or the West operation is advised.

There is a discussion of the condition.

L. L. MAYER.

EFFECT OF HIGH AND LOW CHLORIDE DIETS ON THE SALT CONTENT OF TEARS. D. MICHAIL and L. RUSU, Compt. rend. Soc. de biol. **116:** 1091, 1934.

Subjects deprived of chlorides for twenty-four hours were then given 15 Gm. of sodium chloride by mouth. A progressive increase in the salt content of the tears followed, attaining its maximum in the fifth hour, with a decline to the former level toward the end of the twenty-four hour period of observation. The changes in the salt content of tears with a diet low in chloride were irregular.

J. E. LEBENSOHN.

Lens

IRRADIATION CATARACT. J. G. MILNER, Brit. J. Ophth. **18:** 497 (Sept.) 1934.

Of thirty-six patients examined, twelve had been exposed to the x-rays, one to the x-rays and radium, and twenty-three to radium only. Of the eleven patients exposed to the x-rays in whom a positive result might be expected, nine, or 81 per cent, acquired irradiation cataract. Of the twenty-three patients who received treatment with radium, only three showed definitely positive results. Milner considers that the posterior cortical cataract resulting from irradiation differs in ophthalmoscopic appearance from that of other etiology.

He divides the alterations taking place in the lens into four stages. Stages 1 and 2 are usually seen together. Stage 1 is represented by the formation of vesicles; stage 2, by the appearance of fine dots and feathery lines between and around the vacuoles. Stage 3 is seen in the formation of a central posterior plaque, which is roughly circular with a rim always slightly more dense in appearance than the remainder. In stage 4, the whole lens becomes less transparent.

He agrees with Stallard that defective nutrition of the lens is dependent on damage to the capillaries of the ciliary body.

He concludes that exposure of the eyes to the x-rays or to radium is likely to result in cataract. This cataract has a typical appearance, and its characteristics are vacuole formation, cloudy areas and later a plaque. It also has a constant situation—the posterior cortex of the lens.

There is always a latent period between the exposure and the formation of the cataract, and this can be said to be at least two years. It may be many years.

One course of treatment with x-rays of high voltage is sufficient to cause cataract. Too few cases of cataract due to treatment with radium have been seen to permit one to dogmatize, but it may be said (1) that beta rays, applied at short intervals for short periods, are effective in treatment and harmless to the lens, and (2) that gamma radiation is likely to produce cataract.

Protection of the eyes during treatment is impracticable, but efforts should be made to devise some method of screening the lens without jeopardizing the effect of the radiation.

The article is illustrated.

W. ZENTMAYER.

SENILE CATARACT: POSTOPERATIVE PLASTIC IRITIS; MEANS OF AVOIDING THIS COMPLICATION. V. CERCHEZ, Ann. d'ocul. **171:** 406, 1934.

Plastic postoperative iritis does not occur in patients in whom extraction of the lens is done in the capsule. On the other hand, it is frequent in patients in whom extraction of the cataract has been by removal of the capsule or in whom much lens substance has been left behind. Besides infection, the remaining lens substance undoubtedly plays an important part in the appearance of the iritis. Postoperative iritis may appear not only in persons with a positive Wassermann reaction, but also in those in whom it is negative, as operative trauma

may play an important part in its appearance. This postoperative accident may be avoided by employing atropine and ointment from the second day after operation and continuing to use it regularly for ten days. By this means iritis may be avoided, with the formation of adhesions and the appearance of exudate in the pupil, which even with intense treatment is absorbed with great difficulty and often lessens visual clearness.

Plastic iritis is cured by local treatment alone. General treatment is given only in cases in which it is indicated and must be accompanied by local treatment. General treatment given as a preventive before operation does not help to prevent plastic iritis.

S. H. McKee.

Ocular Tension in Cataract Extraction. T. R. Yanes, Rev. cubana de oto-neuro-oftal. **1:7** (Jan.-Feb.) 1934.

Yanes calls attention to the importance of the work of Ferrer, who insists that study of ocular tension by means of the tonometer is essential in all cases of cataract in which operation is contemplated. Using the McLean instrument Yanes found the normal curve to be between 22 and 40.

When the tension is at the lower limits, experience has shown that manipulations may be more extensive without loss of vitreous. Here simple extraction may be performed without danger of prolapse of the iris, and the use of atropine is advised.

When the tension is near the upper limits, combined extraction is recommended, and atropine is not used after the intervention.

Tensions below 20 should be brought up to or slightly above this point by the use of atropine for some time before operation. Tensions above 40 call for the use of physostigmine or pilocarpine until they are lowered.

S. L. Rhode.

Experimental Studies on Erythropia in Aphakic Eyes. W. Stahel, Arch. f. Ophth. **132:** 1 (March) 1934.

Vogt and Wydler (1912) considered that erythropia, in normal as well as in aphakic eyes, is due to the prolonged and predominant red phase of the after-image which follows absolute or relative dazzling with mixed light. Ultraviolet rays were shown to play no rôle in the mechanism which produces erythropia. That view was recently challenged again by Gualdi (1930), in whose three patients erythropia could be elicited only by ultraviolet rays with or without violet rays. Prompted by Vogt, Stahel studied twenty patients with aphakia about two weeks after the extraction of cataracts. The eyes operated on were first exposed to a big dose of diffuse sunlight by taking the patients for walks at noontime on clear days. Immediately afterward the patients were taken to a semidark room and their color sensations recorded. Only five of the twenty patients showed typical erythropia. White appeared red, green gray, and blue was seen as violet. A few days later the same five patients were again exposed to diffuse sunlight. This time they wore goggles made of very heavy flint glass which absorbs ultraviolet rays completely. Nevertheless erythropia developed

again when the patients were taken back to the dark room. Thus Vogt's view of the prevalent rôle of the visible rays in the production of erythropia was corroborated.

P. C. KRONFELD.

CLINICAL OBSERVATIONS IN GLASSBLOWERS' CATARACTS AND THEIR RELATION TO OTHER FORMS OF CATARACTS. A. MEESMANN, Klin. Monatsbl. f. Augenh. **92:** 289 (March) 1934.

Meesmann reports in detail his observations in glassblowers' cataracts and their relation to cataracts of other origin, and illustrates them by many pictures and tables. He stresses the fact that the nucleus and cortex of the cataract known as senile are not caused by exfoliation of the lens capsule, and that, furthermore, posterior polar opacities and radial dotted formations are not prodromal stages of the senile cataract. Sclerosis of the nucleus and senile opacities of the lens are distinctly symptoms of biologic aging of the patient and of senile destruction of the lens. These are the factors which form the predisposition to the development of lesions resulting from furnace work. This view answers the two questions which Meesmann discusses in his article: 1. The acknowledged symptoms of glassblowers' cataract (posterior polar cataract and exfoliation of the anterior capsule of the lens) are conclusive, although borderline stages occur. Their presence demands search, after maximal dilation of the pupil, for other changes caused by furnace rays, e. g., the presence of fine curved lines in the periphery of the anterior capsule of the lens, which is the beginning of exfoliation. A transition from senile desquamation to exfoliation was observed in one case only. 2. Senile or other types of cataract form a predisposition to the development of glassblowers' cataract but not vice versa. The results of eleven extractions of glassblowers' cataracts are given, six with exfoliation of the anterior capsule and five without it, with good results in nine extractions.

K. L. STOLL.

JUVENILE CATARACT IN DERMATOSIS: CATARACTA SYNDERMATOTICA; REPORT OF TWO CASES. I. KUGELBERG, Klin. Monatsbl. f. Augenh. **92:** 484 (April) 1934.

Kugelberg renders a literary synopsis of juvenile cataract in nineteen cases of sclerodermia and in fifteen cases of neurodermatitis. Familial occurrence was found ten times in the first group and once in the second group. Two cases of juvenile cataract associated with familial neurodermatitis are reported, one in a boy aged 15, the other in a young man aged 26. In neurodermatitis and sclerodermia endocrine disturbances have been noted frequently, especially of the thyroid and of the productive sexual glands. Dysfunction of the parathyroid glands or of the pancreas has never occurred with these dermatoses, nor were they present with similar types of cataracts. It is possible, therefore, that a cataract may be caused by other endocrine disorders than hypoparathyroidism. Hereditary disposition seems to favor the syndrome of sclerodermia and cataract and, to a smaller degree, that of cataract and neurodermatitis. Both types offer sufficient similarities to justify the use of the collective term "cataracta syndermatotica."

K. L. STOLL.

Lids

THE ETIOLOGY AND PATHOGENESIS OF CHALAZION. J. LEVADITI, Compt. rend. Soc. de biol. **115:** 1592, 1934.

The histologic features of a chalazion recall those of a paraffinoma. Staining with scarlet red reveals in the midst of the inflammatory granuloma a mass of globules of fatty material. Large globules of fat, which appeared originally as vacuoles, can likewise be demonstrated in many of the surrounding giant cells. Since the secretion of the meibomian gland is waxy, Levaditi next studied in detail the reactions of animals to injection of wax. He found that injection of bees-wax into the rabbit and the guinea-pig determined a cellular reaction of the same type as in a chalazion, and that when the wax was injected into the lid of a monkey in direct contact with the meibomian gland, the lesion provoked was identical with a chalazion. He therefore considers that the chalazion may well be termed a "steatophagic granuloma."

J. E. LEBENSOHN.

Methods of Examination

MICROMETRY OF THE FUNDUS, DETERMINATION OF RETINAL POINTS AND THEIR SCLERAL LOCALIZATION BY MEANS OF SPECIAL DEVICES ATTACHED TO GULLSTRAND'S SIMPLIFIED OPHTHALMOSCOPE. F. SPINELLI, Klin. Monatsbl. f. Augenh. **92:** 93 (Jan.) 1934.

Spinelli has devised four appliances for attachment to Gullstrand's simplified ophthalmoscope which allow the following examinations: (1) observation of the extreme periphery of the retina by means of a joint in which the ophthalmoscope can be tilted; (2) determination of the apparent size and by a simple mathematical calculation the actual size of a zone or of a point in the retina with a graduated millimeter lens; (3) determination of the parallel either by Lindner's method or by the aid of the millimeter lens; the distance from a retinal point to the extreme limit of visibility of the periphery is measured, to which is then added the known distance between the limbus and the ora serrata; (4) determination and localization of the horizontal and vertical meridians of the cornea by means of the millimeter lens; (5) determination of the meridians either by means of the millimeter lens and the arc of a perimeter attached to the ophthalmoscope, or by a graphic-geometric system, which is referred to the cornea, after localization of the chief meridians.

By the aid of these devices exact micrometry of the fundus can be done without complicated calculations. Therefore they are practical for daily use.

Two objections have appeared as to priority: The first is an article entitled "On Spinelli's Micrometry of the Fundus," by E. P. Fischer (*Klin. Monatsbl. f. Augenh.* **92:** 530 [April] 1934). Fischer refers to his paper on the same subject (*Klin. Monatsbl. f. Augenheilk.* **87:** 577 [Nov.] 1931. He points out his priority and states that Spinelli's devices are superfluous because Weve's apparatus is more simple.

The second is an article, "Remarks on Spinelli's Micrometry," by Miklos Klein (*Klin. Monatsbl. f. Augenh.* **92:** 531 [April] 1934). Klein refers to his publication on the same subject in the Transactions

of the Ungarische ophthalmologische Gesellschaft, 1931 and 1932, and his paper "On Localization on the Fundus, Contribution on Meridian Faults, a New Localizing Perimeter" (*Brit. J. Ophth.* **17:** 145 [March] 1933. He claims identity of Spinelli's and his own methods with the only difference that Spinelli uses the ophthalmoscope, whereas he uses the perimeter.

K. L. STOLL.

TRANSPOSITION OF THE INVERTED OPHTHALMOSCOPIC IMAGE ON THE EXTERNAL SURFACE OF THE SCLERA. A. VOGT, Klin Monatsbl. f. Augenh. **92:** 436 (April) 1934.

Vogt has devised a new method of localizing the tear in detachment of the retina, by the use of which the transposition of the inverted into the direct image, and of the latter on the outer surface of the sclera, is simplified. This method is described and illustrated with sketches and six colored pictures. Errors resulting from the present methods of localization are explained by means of examples, and suggestions are given for a new topographic terminology. It is shown that the expression "farther upward" may have two different meanings as applied to the anterior and posterior segments of the eye. The terms: "temporal," "nasal," "up" and "down" should be replaced by "near the limbus," "away from the limbus" (*"limbusnah," "limbusfern"*) or by "near the macula," "away from the macula" (*"makulanah," "makulafern"*).

K. L. STOLL.

TUBERCULIN AS A MEANS OF DIAGNOSIS IN TUBERCULOSIS OF THE EYE. G. MARQUEZ and S. JIMENEZ, Klin. Monatsbl. f. Augenh. **92:** 628 (May) 1934.

The merits of tubearculin as a means of diagnosis in tuberculosis of the eye were jointly tested by Marquez from the ophthalmologic and by Jimenez from the internistic and pathologic points of view. They made tests with intracutaneous and subcutaneous injections of tuberculin to produce specific focal reactions in suspected cases. They found that the reactions of general and focal pulmonary tuberculosis remained positive in many persons who were found healthy clinically and roentgenologically. The reactions occurred vehemently in a number of these cases. They abandoned these tests, therefore, as unfit for the diagnosis of ocular tuberculosis because of the severe changes that might be produced in the lungs. The intracutaneous method seemed to be superior to the subcutaneous method.

Marquez and Jimenez then tested the effect of instillations of tuberculin in the eye for local diagnostic purposes. They divided their clinical material into four groups, two of them comprising persons with healthy eyes or eyes which were diseased but positively free from tuberculosis. The third group were healthy persons suffering from scrofulous or phlyctenular blepharitis or conjunctivitis, phlyctenular or parenchymatous keratitis, recurring hemorrhages in the vitreous and choroiditis. The fourth group were patients with iridocyclitis, some with healthy and some with tuberculous lungs. The results are reported in detail. This ophthalmoreaction proved to be safe in all the 106 patients who were submitted to it. Positive focal reactions can be obtained by

this method in cases of local tuberculosis and of iridocyclitis. It is possible to get convincing results with doses which are absolutely harmless for healthy and diseased eyes.

K. L. STOLL.

Neurology

THE EYES AS A CAUSE OF HEADACHE. ARTHUR GRIFFITH, Brit. M. J. 2: 296 (Aug. 18) 1934.

Griffith believes that physicians in general do not realize the importance of the eye as a cause for headache. In his own cases 24 per cent of the patients came complaining of headache. The pain can be situated either frontally or orbitally, more rarely occipitally. The time of onset is important. Generally the pain comes on late in the afternoon or early in the evening, though sometimes it may be present on awakening in the morning. If the pain is associated with use of the eyes, it is very likely an ocular headache. The pain can be caused by contraction of the ciliary muscle, as in hyperopes, particularly when the hyperopia is of different degree in the two eyes, and in persons with astigmatism. The headache due to contraction of the muscles of the iris is more debatable. Headaches due to imperfect muscle balance can often be relieved by the use of prisms, but in their prescription great judgment must be exercised. Vertical imbalance seems particularly productive of discomfort and headache. The following procedure is recommended: Have the patient gaze at a distant spot of light, with a red glass before the right eye and a green glass before the left; if these two lights are mixed, the heterophoria does not require correction, but if they are seen separately, the weakest glass which will enable the patient to mix them is the one to be prescribed.

As an explanation of occipital headaches in patients suffering from eye strain, he states that the screwing of the eyes together causes a contraction of the frontal muscle, which in turn pulls on the occipital muscle through the epicranial fascia. The occipital headache is often relieved by pressing on the occipital muscles, and is a form of headache easily helped by wearing suitable glasses.

A. KNAPP.

HEADACHES IN RELATION TO OCULAR CONDITIONS. WILFRED HARRIS, Brit. M. J. 2: 298 (Aug. 18) 1934.

Harris subdivides his subject and first speaks of pressure headaches, which are due to a sudden rise of intracranial pressure. In migraine there is arterial constriction, presumably of the vessels in the cortex of the occipital region, and the subsequent headache is due to the engorgement of the vessels and cerebral compression therefrom, the vomiting being suggestive of raised intracranial pressure. True migraine rarely has any connection with ocular conditions, such as errors of refraction. It often begins early in life and can be traced back to periodic attacks of vomiting that occurred in infancy. Migraine is a periodic headache coming on irregularly, lasting from a half day to two days, and generally associated with nausea and vomiting; often there is a family history of the condition, and other neuroses may be present. Harris does not think that headaches due to errors of refraction

can be diagnosed from their location, and states that troublesome headache which is not periodic and paroxysmal as in migraine should always be treated by corrective glasses. The headache of cerebral arteriosclerosis is mentioned, and he states that diagnosis can be made with the ophthalmoscope.

Finally he speaks of a condition which he terms "maxillary neurosis" or "chronic neuralgia of the jaw." This is a common form of pain in the face usually referred to the cheek, side of the nose and temple, and is peculiar to women. The pain is not paroxysmal but is more or less persistent. No operation on the teeth or the antrum is of any value, and injections of alcohol should be avoided.

A. KNAPP.

BLINDNESS AND ORGANIC CHANGES IN THE RETINA ENGENDERED BY THE PSYCHE. C. L. VAN STEEDEN, München. med. Wchnschr. **81:** 630 (April 27) 1934.

Van Steeden draws attention to the progress made by psychology and psychoanalysis. These subjects have had an increasing influence in changing and modifying present views on general medical conditions. A case is cited of a condition diagnosed as acute retrobulbar neuritis, which was treated with salicylates and in which recovery was almost immediate. He believes that the condition was on a basis of functional hysteria. References in the literature are mentioned which have attributed the frequent occurrence of vasomotor phenomena in various regions of the body to the influence of the brain on the nervous system. He feels that retinitis angiospastica falls into such a category. Cases in which the condition was diagnosed originally as neuroretinitis albuminurica and given a bad prognosis have been known to eventuate in spontaneous and permanent recovery without diminution in renal function. Added to these are the instances of thrombosis of the central artery of the retina which on subsequent examinations were shown to have been cases of psychogenic spasm. Fuchs in his textbook mentions these possibilities. An epidemic of sudden blindness in the Groningen Clinic was traced to the psychic influence of one patient on several others.

Van Steeden emphasizes the fact that more attention should be directed to the possibility of the psychic alteration which simulates an organic condition.

L. L. MAYER.

Ocular Muscles

CENTRAL LONDON OPHTHALMIC HOSPITAL: REPORT OF SQUINT DEPARTMENT, SEPTEMBER 1932-1933. S. PEARSON and S. MAYOU, Brit. J. Ophth. **18:** 267 (May) 1934.

During the first year's work 171 cases were seen. Thirty-four patients were refused treatment as unsuitable for it. The instruments used were the synoptophore, myoscope and the strabismuscope. Home work was done chiefly on the cheiroscope, though in certain cases the stereoscope and the amblyoscope were used. Amblyopia was treated by constant and total occlusion, the size and the opacity of the occluder being lessened as the vision improved. Fusion was obtained with some power of direction before operation in any case. The cases are tabulated to show:

type of squint, age at onset, when correction glasses were given, degree of amblyopia, age at occlusion, time occluded, and results.

It was found extremely difficult to overcome amblyopia from squint occurring in the first two years of life if occlusion was delayed until after the age of 5 years, whereas occlusion undertaken under 5 years of age rapidly resulted in the recovery of good vision. Twenty-one cases of amblyopia are tabulated to show the degree of amblyopia before and after treatment.

Cure in regard to discharged cases denotes the possession of simultaneous perception, fusion and stereopsis. In these cases the angle of deviation on discharge was 0° on the synoptophore, and there was no muscular imbalance shown with either the Maddox rod or the Wing test.

Squint was cured without operation in seven cases. The patients had never at any time when under observation had more than 10° of squint in glasses. With the exception of one, they required on the average fifteen lessons of thirty minutes each.

Eighteen patients underwent operation in addition to orthoptic treatment, and of these nine can be considered cured, while the remaining nine have eyes cosmetically straight and lacking only in stereopsis.

At present 39 patients are under treatment, of whom a certain number are still attending after eight months, which serves to show what an immense amount of work in the present state of knowledge may be necessary to effect a cure.

W. ZENTMAYER.

OCULAR TORTICOLLIS: INFERIOR OBLIQUE TENOTOMY AND ITS INDICATIONS. E. TEMPLE SMITH, Brit. M. J. 1: 374 (March 3) 1934.

A paresis of the superior rectus resulting possibly from an injury at birth leads to a disturbance of the coordinate movement of its component, the inferior oblique, causing overaction, which is followed by hypertrophy of this muscle and upshoot of the eye. The child, to avoid the inconvenience of diplopia, either contracts a convergent strabismus and suppresses the offending image or learns to tilt the head toward one shoulder. The operation of tenotomy of the inferior oblique is described: A quarter of an inch (0.62 cm.) of muscle is excised. Difficulties in defining the muscle are avoided by careful incision of the deep fascia. The tilting of the head ceases, and diplopia is not complained of. Smith suggests that the oblique muscle be tenotomized before operating for the convergence.

A. KNAPP.

A CONTRIBUTION TO THE PATHOLOGY OF CONCOMITANT STRABISMUS. MARTHA VON CSAPODY-MÓCSY, Klin. Monatsbl. f. Augenh. 92: 385 (March) 1934.

Convergent strabismus existed in 315 of 8,000 school children. It occurred more frequently in moderate than in high degrees of hyperopia. A number of reasons were found for opposing the theory that a fault of accommodation is an etiologic factor. The 315 children were, therefore, examined for rickets. They were divided into two groups. The first, consisting of 132 children, had manifest hypermetropia of 2 or more diopters, supporting somewhat the theory of Donders. Of this group 67 per cent had rickets. The second group, 183 children,

showed a hypermetropia of less than 2 diopters or none; 79 per cent of these children had rickets. A comparison with other cities or countries is impossible on account of the geographic difference in the occurrence of rickets. Strabismus was more frequent in the school children than in the children who were treated at the children's clinic for other diseases and in 20 per cent of whom rickets was found incidentally.

The two groups of school children with convergent strabismus showed symptoms of rickets more frequently than those who were treated for other diseases at the children's clinic. It was evident that the spasmophilia produced by rickets plays a rôle in the development of concomitant strabismus.

K. L. STOLL.

FIELD OF VISION IN STRABISMUS; REPORT OF CASES. G. BRAUN, Klin. Monatsbl. f. Augenh. **92:** 600 (May) 1934.

Braun reviews the literature on the field of vision of squinters, reports ten of his own cases and arrives at the following conclusions: 1. The fields of both eyes are normal in alternating strabismus. 2. The field of the leading eye is normal in unilateral squint. 3. The periphery of the field of the squinting eye shows no changes of importance.

An absolute crescent-shaped scotoma, however, is regularly found temporal from the point of fixation in monocular examination with marks 1 mm. in diameter. The size of the scotoma increases under indirect examination, i. e., under guidance of the leading eye, and it is the larger and wider, the more vision is diminished. The nasal border of the scotoma may progress toward the center, and even beyond it if the vision is very poor and fixation is uncertain. Here an actual central scotoma exists, although central fixation seems to be present; an eccentric retinal area takes the place of the fovea, so that the eye becomes accustomed to paracentral focusing. This view is supported by the presence of the blindspot at its proper place.

4. The question whether a central scotoma exists in amblyopic squinting eyes seems to be solved in the affirmative. The results obtained by Braun show, furthermore, that the squinting eye has monocular perception for objects located in the direction of the squint, while it cannot recognize even large letters in the opposite direction.

K. L. STOLL.

Operations

A NEW OPERATION FOR TRICHIASIS. E. JOHANSSON, Klin. Monatsbl. f. Augenh. **92:** 388 (March) 1934.

After proper cocainization of the conjunctival sac and injection of cocaine into the deep layers of the lid, a lid plate is inserted and a section is made down to the tarsus, along the entire lid, 3 mm. above the margin and parellel to it. The tarsus is prepared free downward to the palpebral margin. After this the tarsus is separated from the intermarginal portion and its posterior surface is freed from the conjunctiva for about 1 to 2 mm. Perforation of the flap, consisting of conjunctiva and epidermis, must be avoided. Now a strip, 2 mm. wide, is removed from the anterior margin of the tarsus, and a narrow strip of the epidermis and adherent muscle

is cut off from the upper edge of the wound. The latter flap is put smoothly on the tarsus and fastened with four or five sutures. Satisfactory cosmetic results were obtained. There were no recurrences.

K. L. STOLL.

RESULTS OF OPERATIVE IMPLANTATION OF THE LOWER END OF THE TEAR SAC INTO THE NOSE IN DACRYOCYSTOBLENNORRHEA (MODIFICATION OF TOTI'S OPERATION). W. STOCK, Klin. Monatsbl. f. Augenh. **92:** 433 (April) 1934.

Since 1926 Stock has operated for dacryocystoblennorrhea by implanting the lower end of the tear sac into the nose. Fixation of the wall of the tear sac to the mucous lining of the nose with sutures is rendered unnecessary by this method. An incision 1.5 cm. in length, identical with that in extirpation of the tear sac, is made from 2 to 3 cm. above the lacrimal crest and carried down to the bone. Two retractors are inserted, one horizontal, the other vertical, and the hemorrhage is completely stopped. Then the tear sac and periosteum are separated at the nasal side and severed with a pointed knife as far down as possible in the lacrimonasal canal, and from below up to the canaliculi. The lower end is cut off, creating an opening, and a thread is inserted on each side of the sac, so that the ends of the threads measure 10 cm. The sac is lifted up with a spatula and the retractors are removed. With a trephine, an opening is made into the nose, 10 mm. in diameter. The mucous lining of the nose is pulled forth and cut off, unless it is adherent to the button of the bone. After this the looped end of a wire is passed from the nose through the hole in the bone and the threads fastened through the wall of the sac are laid into the loop and pulled into the nose. The tear sac follows into the nose. The threads are fastened on the cheek with adhesive plaster. The wound is closed with sutures.

Stock devised a special trephine with a cover, which slides back as the trephine advances. The trephine is firmly connected with a small motor of light weight, permitting easy handling. Of forty-five patients on whom this operation was done, twenty-nine returned for reexamination. Of these, twenty-three obtained perfect results. The tear sac had to be removed in four cases later on. In two cases a final cure resulted after the use of probes. Nine other patients reported a cure, two a failure, and five did not answer. Deducting the latter five cases, Stock operated on forty patients, with perfect results in thirty-four and failure in six.

The operation is not used if a small atrophic tear sac is encountered. The tear sac can be extirpated in case of a failure of the implantation operation.

K. L. STOLL.

Orbit, Eyeball and Accessory Sinuses

LARGE ORBITAL CRANIAL OSTEOMA FOLLOWED BY CEREBRAL ABSCESS OF NASAL ORIGIN. J. N. ROY, Ann. d'ocul. **171:** 339 (April) 1934.

In 1930 Roy published an observation concerning a young girl who came for consultation because of a large osteoma of the orbit, which was removed, with conservation of the eye in its physiologic function. The ethmoid was the point of origin of the neoplasm, and notwithstanding the radical removal it reappeared in the same place a few years

later. An observation of interest in the present case is that the osteoma first developed in the orbit and afterward extended into the cranial cavity, with infection of the brain. At operation a large abscess of the frontal lobe was discovered. Roy believes this to be the first case of the kind reported. The details of the case and a summary are given. The patient died of leptomeningitis twenty-eight hours after operation.

S. H. McKee.

The Question of Argyrosis, Especially of the Eyes. W. Gerlach, Klin. Wchnschr. **13**: 797 (June 2) 1934.

A previous investigation of the Kayser-Fleisher ring by Gerlach showed absence of silver in the cornea, which was contrary to Vogt's report. Protocols are given to show the spectroscopic findings when silver salts were used intravenously in rabbits. It was demonstrated that silver could be found in both the anterior and the posterior segment of the eye. He is of the opinion that silver is quickly absorbed in the body tissues, and that this may account for the Vogt determinations.

L. L. Mayer.

Pharmacology

Some Remarks on Pilocarpine. J. A. Van Heuven, Brit. J. Ophth. **18**: 511 (Sept.) 1934.

Hess (*Arch. f. Augenh.* **86**: 89, 1920) found that after putting one drop of a 2 per cent solution of pilocarpine or physostigmine into his own conjunctival sac his vision decreased from one third to one half. At the center of clearest vision a greenish-yellow spot appeared. He explained the phenomenon as due to the direct action of the pilocarpine on the middle layer of the retina. The effect may have been either a spasm of the capillaries or the development of an opacity in the retina.

Van Heuven in the course of eighteen months found four typical cases in which a relative central scotoma was shown objectively after the instillation of pilocarpine. He summarized his study as follows:

Occasionally one meets with a patient of middle age or advanced age who complains after the instillation of drops of pilocarpine of a temporarily serious diminution of vision. This is caused by a spasm of the capillaries in the region of the fovea centralis retinae, as described by Hess.

Experiments on animals to demonstrate this have failed.

By using the entoptoscope of Scheerer, this phenomenon can be investigated and satisfactorily confirmed.

The action of pilocarpine in lowering the intra-ocular tension remains the same when one gives at the same time small doses of a solution of nitroglycerin to the patient by mouth, but the relative central scotoma, if present, disappears.

The same effect can be obtained by using instead of drops of pilocarpine drops containing a mixture of pilocarpine, physostigmine and cocaine. In this procedure the equation 2 per cent pilocarpine solution

is equal to a solution of 1 per cent pilocarpine plus 0.3 per cent physostigmine plus 0.5 per cent cocaine appears to hold good.

The article is illustrated.

W. ZENTMAYER.

THE PHYSIOLOGIC ACTION OF COBRA VENOM ON THE EYE. BAILLIART and KORESSIOS, Bull. Soc. d'opht. de Paris, April 1934, p. 240.

Cobra venom was found to cause the following reactions in the rabbit's eye:

A subconjunctival injection caused congestion of the iris on the side receiving the injection; the pupil was narrowed and took on an oval form; reaction to light was suppressed. This lasted many hours. There was no change in ocular tension. The arterioles dilated, but retinal arterial pressure was not measured.

In man the pupil contracted for a half hour and then resumed its normal amplitude. Tension was lowered from 40 in one eye to 33; in a case of glaucoma, from 35 to 28. This took place in five minutes; the initial tension returned in twenty minutes. The retinal arteries showed a primary contraction lasting fifteen minutes; then dilatation ensued.

L. L. MAYER.

ACTION OF SYMPATHECOLYTIC SUBSTANCES ON MYDRIASIS DUE TO EPINEPHRINE. G. UNGAR and M. R. ZERLING, Compt. rend. Soc. de biol. **116:** 297, 1934.

Instillation of epinephrine (1:1,000) has no appreciable effect on mydriasis; but if, in the dog or the guinea-pig an intravenous injection of ergotamine tartrate or yohimbine hydrochloride is previously given, marked mydriasis ensues.

J. E. LEBENSOHN.

Physiology

ASCORBIC ACID IN THE VITREOUS OF BOVINE EYES. C. DUMAZERT and P. PASSELAIGUE, Compt. rend. Soc. de biol. **116:** 1035, 1934.

Ascorbic acid (vitamin C), which has been demonstrated in the lens and the aqueous, is found likewise in the vitreous. A daily dose of the vitreous from one bovine eye cured induced scurvy in the guinea-pig and stopped further loss of weight. When vitreous was no longer added to the deficient diet scurvy recurred. Following the technic of Kotaki and Nishigaki ascorbic acid was then chemically isolated from the vitreous. Titration reagents indicate that 100 cc. of vitreous contains from 10 to 15 mg. of ascorbic acid and from 3 to 8 mg. of glutathione.

J. E. LEBENSOHN.

Refraction and Accommodation

TINTED LENSES: THE PRESENT DEAL. W. W. COBLENTZ, J. A. M. A. **102:** 1223 (April 14) 1934.

This article was prepared at the request of the College of Physical Therapy.

Coblentz states that although during the past two years there has been some improvement in the fairness of the claims made in the

advertising literature there is still a long way to go in the presentation of relevant facts as distinguished from unproved theories.

The article deals with the advertised claims for certain tints, and points out the fallacy of many of them. Another question that needs clarification is the extent to which the eye is irritated or kept healthy by wearing lenses that either admit or exclude (depending on the particular product that is being promoted) short wavelength ultraviolet radiation, known to prevent rickets, and hence by inference effective in promoting vitality of vision. When one considers that most objects are viewed in reflected light, and that, as a general rule, they (except snow) highly absorb the ultraviolet relative to the visible rays, the presence or absence of the ultraviolet rays seems of minor importance physiologically and for promoting the sale of lenses.

Recent investigators of the merits of new types of wide-vision lenses show that the importance of this improvement appears to be greatly overestimated.

Recently European optometric journals carried advertisements of new laminated, nonshatterable, splinterless safety lenses, claiming absolute and constant clarity, guaranteed for one year. Before these lenses are accepted in this country it would be well to have statistics of the frequency of ocular injury in motoring and other similar pursuits, which are subject to infrequent hazards, as distinguished from occupational hazards, from relatively large flying particles, such as are encountered by machinists, stone-cutters and foundry workers.

For protection from flying particles a single, rather thick (3 mm.), clear glass lens is prescribed (Federal Specifications for Chippers Goggles, G. G. G. — G. 501). In addition to the extra thickness, extra strength is obtained by a special treatment with heat, which results in a uniform radial fracture when the lens is broken by sudden impact. Apparently preference is given to a single piece lens, to insure clearness of vision, instead of a laminated lens of uncertain performances.

W. ZENTMAYER.

PULSATING ACCOMMODATION. L. N. GASSOWSKY and W. G. SAMSONOWA, Arch. f. Ophth. **132:** 82 (March) 1934.

On nineteen of forty normal persons the authors made the following observation: When an object within the range of accommodation was fixed while one eye was examined with a refractometer, the image of the refractometer target on the retina showed rhythmic changes in distinctness. These changes were much slower than the pulse. The two phases of the oscillations, namely, the distinct and the indistinct, usually had the same length. The nature of the rhythmic changes in refraction could not be determined.

P. C. KRONFELD.

THE OPTICAL ELEMENTS OF AMETROPIA. E. TRON, Arch. f. Ophth. **132:** 182 (April) 1934.

Tron has added another 75 eyes to his previous series of 200 eyes on which he or Awerbach or Zeemann determined the optical elements. He now reviews the whole material of these measurements, which con-

tains the following data on altogether 275 eyes: curvature of the cornea, depth of the anterior chamber, anterior and posterior curvature and thickness of the lens and refraction of the eye. These data permit calculation of the axial length. The whole material cannot be considered as representative, because it still is very limited and does not represent a population.

In an attempt to make the material more closely representative, Tron has omitted 32 eyes and makes the remaining 243 eyes the subject of statistical calculations. The refraction of those 243 eyes lies between + 10.00 and — 25.00 diopters. The refractive powers of the corneas, lenses and eyes give frequency curves which resemble very closely the normal variation curve. Only the curve representing the variations of axial length is very abnormal. It is asymmetrical and shows a very high vertex. If the eyes with refractions over — 6.00 are eliminated, the axial lengths also vary in good agreement with the normal variation curve. Sixty of the 243 eyes are emmetropic. In the emmetropic eyes the total refractive power varies between 52.59 and 64.21 diopters, and the axial length between 22.24 and 27.30 mm. Emmetropia results from the combination of any axial length—within the aforementioned limits—with proper refractive power and vice versa.

Ametropia can come about in four different ways: 1. Axial ametropia. The refractive power of the eye lies within the range of variations occurring in emmetropic eyes, but the axial length is either shorter or longer than the limits found for emmetropic eyes.

2. Refraction ametropia. The axial length lies within the limits found for the emmetropic eye, but the refractive power is greater or smaller than the extreme variations of refraction in the emmetropic eye.

3. Ametropia of mixed origin. Both optical elements lie outside of the range of variations found for the emmetropic eye.

4. Combination ametropia. Both optical elements lie within the range of variations found for the emmetropic eye, but they do not fit one another.

In Tron's material the relative frequencies of the four types are: first, 30.2 per cent; second, 3.7 per cent; third, 3.4 per cent; fourth, 62.7 per cent. The combination ametropia prevails among the moderate degrees of refractive errors, while the axial ametropia is relatively more frequent among the high degrees of myopia and hyperopia. In cases with refractions between — 10.00 and + 6.00 types 1 and 3 do occur. The refractive error, therefore, cannot serve as a criterion for the differentiation between types 1 and 3. Most of the cases of "school myopia" fall into the group where combination myopia prevails. Tron considers this fact as an argument against the view that pathologic elongation of the eye occurs under the influence of close work.

In his material Tron has a large number of highly myopic eyes with no or very slight changes in the eyeground. These eyes also belong in the group showing axial ametropia. There seems to be no close relation between the myopic fundus changes and the axial length.

P. C. KRONFELD.

Retina and Optic Nerve

PREPAPILLARY HYALINE VERRUCOSITIES (DRUSEN) IN A YOUNG MAN ACCOMPANIED BY RETINITIS PIGMENTOSA. H. TILLÉ and N. TRANTAS, Bull. Soc. d'opht. de Paris, April 1934, p. 243.

A 29 year old man had had poor vision for ten years. The visual fields were contracted to 10 degrees, and the visual acuity was 5/10. The media showed bilateral discrete posterior polar cataracts, with floaters in both vitrei. The anterior segment and the iris were normal on examination with the slit lamp. The retinal arterial tension and intra-ocular tension were normal. In front of the papillae was a grape-like cluster of translucent white bodies. The peripheries of the retinae showed the typical bone corpuscle pigment formations. General physical examination was entirely negative. The authors review the literature on similar cases and include two excellent photographs of the fundi.

L. L. MAYER.

MEDICAL CONSIDERATION OF THE PROBLEM OF SPONTANEOUS RETINAL DETACHMENT. JEAN-GALLOIS, Bull. Soc. d'opht. de Paris, April 1934, p. 262.

With the presentation of five case reports Jean-Gallois emphasizes the necessity of medical care of patients with detached retina. Traumatic detachment is rare, as shown by observations on 447 cases of cranio-facial injury without ocular complications even in high myopes. Evidence of syphilis or tuberculosis and the possibility of a transudate must be investigated in every case. Inflammatory lesions of the choroid are frequent. Transudates due to renal or vascular diseases must be thoroughly considered. Quincke's edema and endocrine disturbances, especially insufficiency of the thyroid gland and ovaries, may predispose to detachment of the retina. Local vasomotor disturbances may eliminate calling certain detachments "idiopathic." It is believed that permanent surgical cures are greatly dependent on the finding and eradication of some basic predisposing medical condition.

There is a discussion of the condition.

L. L. MAYER.

SUBOCCIPITAL PNEUMOCEPHALY AND RETROBULBAR NEURITIS. M. RENEDO, Arch. de oftal. hispano-am. **34:** 177 (April) 1934.

Renedo reports two cases of apparent retrobulbar neuritis (one acute and the other chronic) of obscure diagnosis and origin which improved remarkably after a cisternal puncture followed by insufflation of air, primarily for diagnostic purposes, subsequently repeated therapeutically. He discusses these cases at great length and with great detail from both a neurologic and a general point of view, inclining toward a tuberculous origin and attributing the beneficial effect to a result similar to that of the injection of air into the peritoneal cavity in tuberculous peritonitis; he believes that the insufflated air by producing meningeal irritation and congestion overcomes the resistance

of the hemato-encephalic barrier and thus favors access to the affected region of the methenamine subsequently used. C. E. FINLAY.

TRICHINIASIS AS AN ETIOLOGIC FACTOR OF OPTIC NEURITIS. M. V. POVOLOTZKAYA-BURSTEIN, Sovet. vestnik oftal. **5:** 476, 1934.

This case of trichiniasis is reported because of the unusual ocular complication. A man, aged 43, complained of blurred vision. The day previously he ate some pork and all the symptoms of trichiniasis developed—edema of the face, fever, pain in all muscles and eosinophilia up to 28 per cent at the height of the disease. On ophthalmoscopic examination both eyes showed optic neuritis. The borders of the disks were indistinct and were covered with peculiar radiating white lines. The vision and the visual fields were impaired but slightly. This condition lasted for about two months, after which the vision and fundus returned to normal. O. SITCHEVSKA.

Trachoma

TRACHOMA IN THE INDIANS OF WESTERN CANADA. J. J. WALL, Brit. J. Ophth. **18:** 524 (Sept.) 1934.

Wall states that the situation relating to trachoma among the Indians of western Canada, viewed from the economic, humanitarian and public health standpoints, constitutes a serious problem. The disease is distributed from Ontario westward through the prairie provinces and into British Columbia. Ontario has the lowest incidence. In certain settlements from 42 to 50 per cent of the Indians are infected. Factors contributing to the heavy incidence and severity of the disease are high altitude, finely pulverized alkaline soil, frequent sand and desert storms, and intense heat and extreme dryness of the summer season. In the areas of greatest incidence 70 per cent of the cases of markedly impaired vision or incurable blindness are due to this malady.

The general lack of elementary individual hygiene in many of the Indian houses plays an important rôle in the dissemination of trachoma. The general Indian conception of the disorder is not that of a communicable disease. The possibility that the Indian will introduce the disease into the white population must not be overlooked.

Certain observations of interest are: Trachoma is a familial disease. In certain cases it tends to be more resistant to treatment, especially if an accompanying scrofulous diathesis exists. Climate and local factors have an important bearing on the incidence and the severity of the infection. Certain members of families in which trachoma exists appear to have an inherent immunity to the disorder. In some cases with the history of total absence of treatment the disease becomes quiescent. Trachoma does not run a steadily progressive and destructive course. W. ZENTMAYER.

BIOMICROSCOPIC STUDY OF THE LIMBIC REGION IN TRACHOMATOUS EYES. E. GALANTE, Rev. internat. du trachome **11:** 6 (July) 1934.

In biomicroscopic examination the normal limbus presents from the periphery inward three vascular zones: one of palisades, one of marginal loops and one of terminal capillary loops. In healthy eyes,

the first two zones are almost bloodless. In trachomatous eyes, the groove normally seen between the first and second zones is filled by an edema; the capillary zone is markedly developed, and a halo surrounds the larger vessels, indicative of an intralamellar edema. In the intervening tissue, white-gray elements interspersed between more transparent spaces produce a grating-like image.

J. E. LEBENSOHN.

FAVORABLE EFFECTS OF TARSECTOMY BY THE CUTANEOUS ROUTE IN THE AMELIORATION OF TRACHOMATOUS LESIONS. F. MOTAIS, Rev. internat. du trachome **11:** 65 (April) 1934.

Of 115 patients subjected to ablation of the tarsus by the cutaneous route, 75 per cent had comfortable eyes within two weeks, and only 14 required any considerable further treatment. The operation is indicated in all cases of stubborn trachoma, with obstinate irritation, pannus and thickened tarsus, whether entropion is present or not. Whereas tarsectomy through the conjunctiva may often provoke a recrudescence of corneal ulceration, this modified procedure allays the inflammatory process from the start.

Motais submits a detailed and illustrated account of the operative technic, and concludes that tarsectomy thus performed is the most valuable therapeutic adjunct in the management of chronic trachoma. Its efficacy is probably due to the removal of the tarsal glands, for in trachoma there is not only a granular conjunctivitis but a tarsal adenitis.

J. E. LEBENSOHN.

COPPER CITRATE IN THE TREATMENT OF TRACHOMA. E. SELFA, Rev. internat. du trachome **11:** 84 (April) 1934.

The intravenous use of copper in the treatment of trachoma was introduced by Meerhoff in 1926. In 1927, Marques confirmed the value of this treatment, but used, instead of ammoniacal copper sulphate, copper citrate dissolved in sodium citrate, which is both more stable and noncoagulant.

The remedy is generally quite safe, since the toxic dose is far beyond that administered therapeutically, and absorption is extremely limited. However, since copper is deposited in the liver, patients with excessive sensibility or with preexisting hepatic disease may show jaundice, and in such cases the intravenous use of copper is contraindicated.

This treatment has no effect on follicles or papillae, but often promptly alleviates corneal ulceration, lacrimation and photophobia. Of twenty-nine patients treated, two-thirds were benefited after the first injection. If definite amelioration does not follow the second injection, further treatments are of no value. The dose is 80 mg. (1¼ grains), repeated every three or four days.

J. E. LEBENSOHN.

Uvea

REMAINS OF EMBRYONIC IRITIS. BAUDOT and GAULT, Bull. Soc. d'opht. de Paris, March 1934, p. 183.

The authors report two cases of iritis of embryonic origin studied under the slit lamp. The first patient, a man of 47 years, showed along

the temporal pupillary border an exudate made up of fine white vessels which moved with the pupil. Over this were fine brown-pigmented synechiae which ran from the border of the pupil to the anterior capsule of the lens. The left eye was similar. The patient had subacute glaucoma and a positive Wassermann reaction.

The second patient was a girl of 9 years. The lenses were congenitally subluxated below and outward. Secondary glaucoma had existed for over two years. White synechiae of the iris, more marked during myosis, were noted at 6 o'clock. In neither case did the synechiae distort the pupils, a characteristic of the iritis occurring during embryonic life. Both patients showed signs of hereditary syphilis and secondary glaucoma.

L. L. MAYER.

PIGMENTED, EDEMATOUS CHORIORETINITIS. METTEY and REDSLOB, Bull. Soc. d'opht. de Paris, March 1934, p. 193.

A woman of 26 years complained of a mist before the left eye that had been present for six months. During the last three months there had been an increase in the clouding. The previous history was not relevant. The refraction of each eye was normal, but while the visual acuity of the right eye was 1, that of the left was only 0.03. The media were clear. Minute examination of the left fundus revealed only a single lesion in the macular region. It was twice the diameter of the disk, regular in outline, uniformly grayish-yellow and circular, but whether the fovea was entirely involved could not be determined. Physical examination and all laboratory tests gave negative results. Preparations of mercury and iodides were used. Five days after the first examination, edema of the papilla was noted. This persisted for one year. After four years only perception of light remained, and signs of pigmentary degeneration of the retina occurred in this area. Because the lesion resembled a sarcoma of the choroid, the eye was enucleated. The tension was normal. Pathologic examination showed a pigmentary degeneration of the retina accompanied by transudation and sclerosis of rods and cones.

L. L. MAYER.

Vision

THE INFLUENCE OF STARVATION ON VISUAL FUNCTION. S. W. KRAKOV and E. N. SEMENOVSKAJA, Arch. f. Ophth. **132**: 370 (Aug.) 1934.

A male patient, 38 years of age, received no food except water for fifty days (for the treatment of a cystitis). His dark adaptation was studied with an instrument similar to Nagel's on the forty-fourth day of the period of starvation and again two weeks after the patient had been put on a regular diet. The latter curve was well within normal limits, while the former showed severe hemeralopia.

P. C. KRONFELD.

Society Transactions

GERMAN OPHTHALMOLOGICAL SOCIETY

Fiftieth Annual Meeting, Heidelberg, Aug. 6 to 8, 1934

PROF. DR. FREDERICK POOS, Münster, Germany, *Reporter*

ABRIDGED TRANSLATION BY DR. PERCY FRIDENBERG, New York

Opening Session, August 6

The Chairman, Privy Councilor Prof. Dr. Wagenmann, referred feelingly to the Nation in mourning for its lost leader, Reichs-President and Field Marshal Hindenburg, to his eminent services in peace and war, and to the sterling qualities of character, sense of duty and love of country which had made him so generally respected and beloved. A standing silence of the members paid honor and respect to the memory of the dead hero. In retrospecting the position in which the country found itself three years previously, when the Society met at Leipzig, the Chairman called attention to the providential change which by good fortune saved it from utter chaos. "We cannot be sufficiently thankful to our destiny for sending to our Fatherland our great leader Adolf Hitler who, called by our highly honored and now deeply lamented Reichs-President von Hindenburg to be Imperial and National Chancellor, seized the helm of our ship of state, threw it around from its course toward an imminent yawning abyss, and rapidly led it uphill. A cleansing tempest roared across our Fatherland, and the mighty movement brought about a complete reversal of all relations. This revolutionary movement has given ophthalmologic science, too, a new direction, a new point of view. New problems have arisen, and certain branches generally slightly cultivated, such as ethnology and racial hygiene, have come into the foreground. Important postulates of long standing, theoretically and scientifically, have acquired force and actual practical significance through appropriate legislation having as its basic purpose the prevention of a hereditarily diseased progeny. Our field of science and activity is also concerned directly, as congenital, hereditary blindness and developmental defects must be limited and prevented. It is a legitimate task of purely scientific societies such as that to which we belong to cooperate, to handle these problems and to stand ready when medical questions arise which concern the community. Our Societies must back up the Führer loyally, grasp the demands of the times, and work together for the aid of suffering humanity and the realization of the new ideals.

"This year's session is particularly significant in that it is the fiftieth since the foundation of the Society, and we were able in 1933 to look back on seventy years of the Society's activity."

The Chairman then gave an interesting review of the historical development of the Society from its first meeting under Albrecht von

Graefe in 1857 to its present size and importance which extend far beyond the limits of the German Fatherland. He emphasized the importance of the continuation of this scientific standing, of unconditional adherence to traditional principles of "external organization and internal attitude," closest relations with the natural sciences and intimate connection with general medicine so as not to be lost in the narrow bounds of a specialty but to have one's gaze fixed always on the broad aims of medicine. "May the spirit of Albrecht von Graefe continue to animate the Society which he founded, and may our meetings, as heretofore, be counted among those which stand in the front rank of sessions dealing with applied science. One more great scientific datum, which lies fifty years back, must be brought to mind. Fifty years ago, at the sixteenth meeting of our Society, at its opening session, here in Heidelberg, on Sept. 15, 1884, the first preliminary communication of Koller's discovery of the local anesthetic action of cocaine was presented. Thereupon Koller became the founder of local anesthesia. Ophthalmic surgeons of the present generation cannot have any conception of the truly blessed effect, for both physician and patient, of the introduction of cocaine. Koller became, through this procedure, a benefactor of mankind, and we have every reason to express our deepest gratitude. Finally we must thank and do honor to the memory of a great man of science the one hundredth anniversary of whose birth falls on August 25 of this year and who contributed in an outstanding manner to the progress of ophthalmology by his fundamental work in the field of the physiology of the special senses: Ewald Hering.

Scientific Session, August 6

DR. SCHIECK, WÜRZBURG, *Chairman*

INHERITANCE OF GLIOMA OF THE RETINA; REMARKS ON THE MENDELIAN RULES. DR. BEST, Dresden.

The exact nature of the inheritance in cases of glioma of the retina has not yet been cleared up. By some, this defect is considered a dominant, by others a recessive, characteristic. Certain data speak against inheritance as an important or decisive factor. Gliomatous children die before they have reached a procreative age. The sporadic cases are usually (at least 85 per cent) unilateral in spite of the fundamentally equal hereditary factors of influence in both of "twin eyes." Furthermore, in 48 unselected cases, studied as they came under observation, Hemmes found no heredity and no influence of consanguinity, even in the offspring of patients operated on for glioma. Davenport's 27 cases presented the same findings. Speaking in favor of a hereditary factor, one has the familial occurrence—unusual, it is true—in which occasionally all the children of a phenotypically sound parent-pair become affected. In these cases the involvement is generally bilateral. The significance of direct inheritance is increasing. In 1905 there was only 1 case recorded in the literature; in 1916 but 3, and in 1929, 12. The lack of evidence of inheritance in cases of sporadic glioma and the multiplication of cases in families in which familial glioma appears might be explained by the hypothesis that a mutation occurs, which is

not necessarily a hereditary one. The possibility of a coupling with some other gene should be rejected, as the gliomatous children and gliomatous families appear hereditarily sound in other respects. One gets some light on the part played by hereditary influence if one studies the development of a normal characteristic property in twins and in the twin eyes of one and the same person and compares the modification spread (e.g., for corneal refraction) with the much greater discrepancies of manifestation in developmental malformations. It may be taken as a rule that the more a congenital developmental anomaly varies from the normal, the greater the variations in manifestations and the more frequent the "polyphane" manifestations. In regard to glioma and, to a certain degree, other serious developmental ocular disturbances, the mendelian rules do not hold good and cannot be applied consistently. It seems that one might accept as an additional factor some unknown disturbance precipitated, as it were, by heredity and capable, then, of carrying through against normal development. Practically, one must demand, as against Hemmes, the sterilization of patients with sporadic glioma, as well. Best reports a case of unilateral sporadic glioma in a child (the only one so affected among 7 children) of whose 3 children 2 had bilateral glioma; 1 was cured by roentgen therapy.

FAMILIAL ATROPHY OF THE CHOROID WITH ATAXIC DISTURBANCES (PRESENTATION OF CASES). DR. KAPUSCINSKI SR., Posen.

Degenerative processes in the soft tissues of the posterior portion of the globe are described as atypical retinitis pigmentosa, whereas such conditions do not resemble each other and, what is more, do not resemble retinitis pigmentosa. One must differentiate sharply from the last-mentioned disease, the tapetoretinal syndromes, Fuchs' atrophia gyrata chorioideae et retinae and its varieties, without denying the essentially heredodegenerative nature of all of these diseases and their genetic reciprocal relations. Three cases are reported of a choroidodegenerative syndrome in 3 siblings with ataxic manifestations resembling Friedreich's ataxia, also with infantilism and retardation of mental development. In the two youngest patients, ophthalmoscopic examination showed an extensive degeneration of the choroid with sclerosis of the choroidal vessels and clumplike accumulations of pigment in the periphery. In the case of the oldest sister, there was complete degeneration of the choroid. Myopia of high degree was present in all three cases. Still, the disk showed a comparatively good color, and the retinal vessels were not markedly contracted. In all of these cases the disease began in about the sixth year of life with hemeralopia, gradual deterioration of vision, and concentric contraction of the visual field which progressed, in the case of the oldest patient, to complete blindness. This condition resembles that described by Fuchs so far as the subjective symptoms are concerned, but differs from it in the appearance of the fundus and in the somatic-psychic syndrome complex.

THE IDENTICAL ETIOLOGY OF HITHERTO UNEXPLAINED JUVENILE OCULAR PARESES. DR. PASSOW, Munich.

Earlier publications of mine have shown that many previously obscure cases of Horner's syndrome and heterochromia can be explained

by a uniform etiology, viz., embryologic developmental defects in the region of origin of the sympathetic nerves. One evidently has to deal here with the same biogenetic inhibition as in spinal raphe formation or dysraphia to which Henneberg relates syringomyelia and Bremer, the so-called "status dysraphicus." The last-named status was shown to be present in 64, or more than 80 per cent, of Passow's patients affected with Horner's syndrome and heterochromia, so far as the latter condition was not heterochromia simplex or a depigmentation of the iris due to inflammation or following injury, and the syndrome, the origin of which was previously obscure, could be traced back to early youth or to childhood. Subsequent to these publications, careful investigation of 14 more cases of Horner's syndrome or heterochromia with or without other complications (precipitates, lenticular opacities) always gave quite the same data. Illustrating the last series of cases, I present a large number of photographs, many in color, showing the local, ocular changes and also those stigmas, accessible to photography, which are demonstrable evidence of the underlying pathologic status. Among these are: anomalies of the sternum; funnel chest; asymmetry and inequality of the breasts, the smaller, anomalous breast being always on the same side as the anomalous eye; heterochromia of the mamilla mammae, corresponding to the heterochromia of the iris; excessive length of the arms; spinal curvature, and many anomalies in the bony structure of the hands. These observations confirm the theory that there has occurred a developmental arrest in the sympathetic fibers of the cervical medulla as the etiologic factor of the Horner-heterochromia syndrome. The question then arises whether there are indications of this particular pathologic status in patients with congenital or juvenile abducens or facial paralysis, for which clinical and serologic investigation has failed to give a satisfactory etiologic explanation. As a matter of fact, there were, in 11 cases of abducens paresis, any number of the characteristic symptoms of status dysraphicus. Heredobiologically deserving of special mention is the case of a woman with congenital paresis of the left abducens, Horner's syndrome on the left side and heterochromia of the left eye with many signs of the status, whose 2 year old son also showed paresis of the left abducens, Horner's syndrome on the left side, a definite funnel chest and scapulae alatae. In the more rare (6 cases) congenital or juvenile instances of facial paresis, too, there were many symptoms of the status. There were symptoms of peripheral paralysis affecting all three branches. [Diagrams of the disturbances of sensibility in the area of the trigeminal nerve were demonstrated.] All of these disturbances are to be summed up as due, in the last analysis, to developmental arrest in the form of gliosis or vacuole formation in the upper thoracic and cervical medulla and in the medulla oblongata, leading to motor, vasomotor-trophic or sensory disturbances. This is of practical clinical significance in view of the well known fact that many cases of embryonic heterochromia are attributed (on account of the quite common presence of precipitates and lens opacities) to inflammatory or even tuberculous processes, just as bulbar oculomotor pareses, which, like other stigmas of status dysraphicus, are of prenatal origin, are diagnosed as syphilitic or rheumatic, or as due to some other disease of the brain or cord.

DISCUSSION OF PAPERS BY DR. BEST, DR. KAPUSCINSKI SR. AND DR. PASSOW

DR. CLAUSEN, Halle: It is quite out of the question to postulate, as Best does, that hereditary disturbances of paired organs inevitably and necessarily occur bilaterally. Take, for instance, coloboma of the uveal tract, which so often appears on one side only. There seems to be no doubt that here one has to deal with a certain independence or individuality of each of the eyes. From previous experience it cannot be denied that nonhereditary gliomas do occur, but the more carefully one investigates each individual case of glioma for evidence of inheritance, the more often one finds some definitely hereditary factor. In general, glioma seems to be a recessive characteristic. This explains the comparative frequency of glioma in the Jewish race, in which, in a certain sense, inbreeding is more common than in other races. In all hereditary diseases one occasionally notes a variation or reversal of valence, so that a recessive hereditary abnormality suddenly becomes dominant. In an exactly analogous way, one may occasionally see a glioma, unilateral and recessive in the ancestry, appear bilateral and dominant in the descendants, as in a recent observation of a father and his 2 children.

DR. FLEISCHER, Erlangen: The irregularity of the inheritance of glioma forcibly suggests the probable presence of other factors, predisposing or inhibitory, which one may have to look for in the cell protoplasm. My own observation of glioma in 3 successive generations without blood relationship shows that the glioma factor must be directly inherited. The practical conclusion is that subjects with glioma should not be allowed to have offspring. Examination and careful study of twins is of great importance for ophthalmology.

DR. BÜCKLERS, Tübingen: Study of 49 cases (among 310,829 patients) in Würtemberg, most of which ended fatally, showed that the question of inheritance is still obscure. As to the genetically equal development of both eyes postulated by the reader of the paper (Best), anisometropia, for one thing, speaks against it so far as the field of refraction is concerned. Variations in manifestation also occur in glioma; viz., "rudimentary" glioma. H. K. Bauer considers the problem of neoplasm to be, in the last analysis, a question of chromosomes, and more especially and probably, one of atypical numbers. Besides the influence of the chromosomes (Mendel), one must consider another heredobiologic base which, according to Plate, is localized in the remaining nuclear plasma.

DR. LÖHLEIN, Freiburg: I question Best's conception that the less marked the deviations from the normal, the more surely the hereditary factor must affect both eyes equally. This is contradicted by clinical experience, e. g., the observation that quite rudimentary coloboma of the iris is often unilateral. Does Passow consider the precipitates quite frequently seen as complications of heterochromia, and other "inflammatory" changes, as the result of a disturbed function of the sympathetic nerve? Or are these changes to be interpreted as acquired and possibly infectious factors setting up inflammatory processes in a locus minoris resistentiae presented by an iris which has an inheritance of trophic inferiority?

DR. BEST, Dresden: It was the observation of unilateral occurrence of coloboma of the iris and/or choroid which led me to believe that in serious developmental disturbances one is dealing not only with the factor of hereditarily unalterable "genes." Investigation of twins and comparison of both eyes of one and the same subject generally lead to the same conclusions, except that in the latter subject the spread of modifications is more decidedly limited. But this study of twin eyes in one subject can tell one nothing about the factor of symmetry in the inheritance, e.g., of anisometropia or of the "discordance" of the ophthalmoscopic picture in the two eyes of the same person.

CONGENITAL ATRESIA OF THE NASOLACRIMAL CANAL. DR. SCHWARZ, Tübingen.

Serial frontal sections of the nose in the fetus and newly born infant showed atresia of the nasolacrimal canal in about one third of 207 specimens. Persistent closure results in a dilatation of the lacrimal duct and sac, which begins at about the eighth or ninth month, increases with age, and finally becomes very marked. The closed end of the lacrimal canal occasionally protrudes into the inferior meatus to such an extent that the large terminal "cyst" or bulla may be recognized clinically in the living subject on rhinoscopic examination. This dilatation must be interpreted as an ectasia supervening on a stenosis or closure such as always ensues in hollow viscera in which a stream of fluid moves forward with a certain degree of force. If this hypothesis is correct, it follows that there must be in the last months of pregnancy an active current of tears, if a dilatation of this sort develops on the basis of a persistent atresia. The impulse of motion comes from the canaliculi or rather from a structure of striped muscle surrounding them, which probably is activated simultaneously with the opening and closing of the eyelids. This also explains the increased off-flow of tears with frequent or rapidly repeated blinking. In a certain number of the cases, the opening of the canaliculi into the lacrimal sac showed indefinite formation of folds, which may occasionally assume the function of valves.

DISCUSSION

DR. FLEISCHER, Erlangen: A remarkable feature is the high percentage (35) of ostia still closed during the last three months of pregnancy. As this kind of atresia is a comparatively rare occurrence after birth, the majority of the still closed ostia must open up spontaneously at or soon after birth. Perhaps the reader of the paper has another explanation of this finding.

DR. COMBERG, Rostock: The clinical conditions speak only for the relatively rare presence of a true atresia of the nasolacrimal duct. In most cases the nasolacrimal canal opens shortly after birth or in the first four months, so that an immediate attempt at passing probes is as unnecessary as it is dangerous. Watchful waiting and the use of mild antiseptics may be instituted with entire peace of mind. A series of personal clinical observations show unquestionably that the canal often opens up after the use of a solution of zinc sulphate, 3 per cent (*sic*), with the addition of cocaine, 2 per cent.

DR. SCHWARZ, Tübingen: In comment on Fleischer's statements: Even slight injuries, especially the traumatism incidental to delivery, are capable of bursting the terminal bulla of congenital atresia, which is usually thin and delicate. This explains the relative infrequency of congenital atresia in early infancy or, in fact, in any postfetal stage, compared with the great frequency in my material. The agency of a closed canal in these cases was shown always and unmistakably by the fact that the ectasia was found invariably in association with a closed ostium and never with an open one.

EXPERIMENTAL SUPERINFECTION IN HEMATOGENOUS, "ISOLATED" UVEAL TUBERCULOSIS. DR. WEGNER, Freiburg.

Experimentally produced ocular tuberculosis almost invariably presents pathologic pictures which are quite unusual in human beings. The animals succumb as a rule to a severe general infection, while the local process, at least when produced by way of the blood stream, is benign and runs a mild course. However, by inoculation of tubercle bacilli into a ciliary vein against the blood current a uveal tuberculosis can be produced which drags on for many months while the internal organs remain free or, at most, show only the slightest involvement. When tubercle bacilli of the human type were used, even when they were injected into the blood stream, the infection never came to an involvement of the fellow eye. Experiments in superinfection of rabbits which had a chronic uveal tuberculosis of from ten to twelve months' standing by the injection of tubercle bacilli into a ciliary vein showed that this intra-ocular process offered decided protection against the effects of a renewed importation of tubercle bacilli. This protection or immunity of the first eye inoculated extended even to the fellow eye, which showed itself able to withstand the mass attack of tubercle bacilli injected into the ciliary vein, and to throw off the infection with little or no reaction. The experiments gave no evidence that the settling of tubercle bacilli in one eye resulted in a reduction of resistance in the organism as a whole. It was not possible to confirm the well known observations of Löwenstein, who induced unilateral (monocular) chronic tuberculosis of the iris by inoculation of bacilli into the anterior chamber and, on practicing superinfection eleven months later by injecting the bacilli into the vein of the ear, noted the development of a severe choroiditis in the other eye in every case. On the contrary, the experiments reported in this paper appear to show that tuberculous infection of one eye is to some extent a protection for the fellow eye. Accordingly, one must decidedly reject the therapeutic application which would logically follow if one accepted the teachings of Löwenstein's experiment, viz., to enucleate the eye first affected, following the example of genito-urinary surgeons in tuberculosis of the kidney.

CLINICAL OBSERVATIONS IN AUTOHEMOTHERAPY (INJECTION OF PATIENT'S OWN BLOOD INTO ANTERIOR CHAMBER) IN TUBERCULOUS IRITIS. DR. SERR, Heidelberg.

Since the end of 1932, 41 patients were treated according to Schieck's method. Injections were made into the anterior chamber of 52 different

eyes; some were repeated, so that there were 63 injections in all. Only local treatment (atropine, hot applications, etc.) was used in addition; in order to have clear and unambiguous conditions, all general treatment was abstained from. For the same reason, no tuberculin was used, even for diagnostic purposes. Of the 18 eyes followed up, so far for less than half a year, 14 had recovered and remained well; 3 showed no improvement, and 1 had become worse. It is concluded that Schieck's procedure of injecting the patient's own blood into the anterior chamber is a valuable addition to the means of combating tuberculosis of the iris. Thirty-two eyes showed rapid clinical improvement following a single injection into the anterior chamber, and 5 other eyes, definite improvement after repeated injections. Of 34 eyes followed up for more than half a year, 23 had remained without a relapse—14 of them for more than one year. In 10 eyes there was no improvement, and in 1 there was a change for the worse.

USEFUL AND HARMFUL THERAPEUTICS IN TUBERCULOSIS. DR. WERDENBERG, Davos.

In the treatment of patients with ocular tuberculosis the aim is to cure the entire process in the organism by general treatment and not by treatment only of the local disease. Its basis is a knowledge of the entire disease picture, of the principal clinical forms of ocular tuberculosis, of the primary, generally intrathoracic origin of the infection, and of generalized tuberculosis. The nosologic character of ocular tuberculosis is often masked. The point of attack of any useful therapy is the organism as a whole, especially in the initial phase of the disease, and the attempt should be made to change the key, to swing or transpose the constitutional tuberculosis into a more benign form of the disease. A second favorable phase is that in which there is a favorable response to aggressive general and local treatment, such as specific therapy, treatment with x-rays and so forth. Two main clinical groups of ocular tuberculosis stand in therapeutic opposition: malignant, exudative forms, with the subjects toxin-sensitive, calling for conservative, general and local treatment, on the one hand, and on the other, benign, productive or fibrous forms, with the subjects less toxin-sensitive, indicating a more aggressive therapy. The factors of cure act differently in different disease forms and according to the varying quality of the pathologic process. On this basis, therapeutic results were attained in more than 1,000 cases of tuberculous disease of the eye, largely of severe forms. There was recovery in 54 per cent, improvement in 38 per cent, and useful vision of from 1/6 to 1, after what had amounted to practical blindness, in 72 per cent of 300 eyes. Three groups of therapeutic damage are distinguished: (1) specific toxic damage as a result of incorrectly applied or directly contraindicated tuberculin therapy; (2) local, irritative damage from roentgen therapy, subconjunctival injections, injections of the patient's own blood into the anterior chamber in some exudative cases, and operative procedures, such as iridectomy in the florid stage; (3) damage through general treatment and general factors, overexertion in sports, inappropriate heliotherapy as indicated by the intrathoracic findings, undernourishment, and a "one-sided" raw diet.

JUVENILE RELAPSING VITREOUS HEMORRHAGES AND ENDANGIITIS OBLITERANS (BUERGER). DR. MARCHESANI, Munich.

The disease picture in the eye is uniform in that it generally (75 per cent) affects young adult males, who are on the average 26 years old. Occasionally one finds, in addition to the retinal disease, an iridocyclitis, which may well be due to the same cause. The condition is viewed today in Germany as a tuberculosis of the retinal vessels, and its occasional occurrence in tuberculous subjects (Axenfeld and Stock), as well as the histologic observations (Fleischer), seems to speak in favor of this interpretation. As a matter of fact, definite indications of tuberculosis are clinically lacking in most cases, and this is explained by the axiom that true ocular tuberculosis and pulmonary phthisis are, at least to a certain extent, mutually exclusive. If examination is directed to this end, one can elicit in these patients symptoms of thrombo-angiitis obliterans (Buerger), a condition which may lead to gangrene of the extremities in youthful, predominantly male subjects. There may be present abnormal sensations of cold, especially in the legs; a predisposition to frostbite; marked sweating of the hands and feet; reddish or bluish discoloration of the extremities; trophic disturbances of the nails or of the skin; exanthematous changes; disappearance of the pulse in the arteria dorsalis pedis and the arteria tibialis posterior (in one case of gangrene of the extremities due to excessive cold); neurologic symptoms pointing to multiple foci in the central nervous system and giving the impression of an atypical form of multiple sclerosis; digestive disorders; colic, and embarrassed heart action. Capillary microscopy shows disturbances in the form of slowed circulation, dilatation of the anastomoses and capillary hemorrhages. The involvement of the retinal vessels, which leads to thromboses, obliteration of vessels, hemorrhages and the formation of anomalous anastomoses, represents an ocular localization of Buerger's disease. The fact that this pathologic process may run its course in any one or in a number of different vascular areas of the body has of late acquired increasing significance in pathology (Jaeger). The histologic observations in the ocular tissues are characteristic and typical of thromboangiitis obliterans. The incorrect interpretation of the process as tuberculosis of the retinal vessels may be due to the occasional resemblance of the occluding tissue to tuberculous granulation tissue. Etiologically, clinical observations show a familial vasopathy as a basis on which various exogenous factors of damage, such as cold, traumatism, infection, abuse of nicotine and endocrine disturbances, may give rise to manifest disease. But the final word on the etiology has not been spoken. In the stage of gangrene there has been no improvement with the use of vasodilators or with periarterial sympathectomy. These procedures seem to be of doubtful value. Whether they would be of value in earlier stages of the disease than that in which it generally comes under observation remains for experience to teach.

DISCUSSION OF PAPERS BY DR. WEGNER, DR. SERR, DR. WERDENBERG AND DR. MARCHESANI

DR. STOCK, Tübingen: Clinical experience seems to speak against the hypothesis that tuberculosis in one eye acts as a protection for the

fellow eye. One sees again and again that the second eye becomes affected, sometimes months after the first and, what is more, just as severely. And, too, it seems to me that the experiments are not sufficient in number; with such delicate inoculations, errors can easily creep in and lead to false conclusions. With reference to Serr's paper, in spite of the good results shown in the statistics, I am not convinced of the efficacy of injection of the patient's own blood into the anterior chamber. Such statistics have been presented again and again in the last few decades. One need only think back to the era of tuberculin and to that of injections of air into the anterior chamber. During the last half year I myself have had a statistical table made of the results of roentgen therapy, which shows equally good results, and yet I know that there is less in this form of treatment, too, than I thought at first. In regard to Werdenberg's statements, the question at once arises whether roentgen therapy does any lasting damage. I myself have seen such reactions. In fact, it was just the patients with the marked reaction that seemed to be most beneficially affected. However, I have never observed any permanent damage.

Dr. Fleischer, Erlangen: In regard to my case of "juvenile periphlebitis" with histologic examination (*Klin. Monatsbl. f. Augenh.* **52:** 769, 1914), I should like to call attention to the fact that, in addition to occlusive processes in vessels of the posterior section of the globe, there were definite clinical indications of tuberculosis of the lungs, as well as nodular iritis with precipitates. In this case there was certainly a high degree of probability that the condition was tuberculosis. However important and noteworthy the observations and investigations of the reader of the paper, one cannot exclude the possibility that a similar disease picture (endangiitis tuberculosa) may be presented which depends on an entirely different cause.

Dr. Löhlein, Freiburg: In reference to Marchesani's comments, a detailed report of the case examined histologically by Axenfeld and Plocher was not published, because Axenfeld wanted to wait until he had more material of a convincing nature. However, in the case reported at that time, an operation had been performed for tuberculous glands of the neck with cheesy degeneration. This case, as well as other clinical cases in which a typical tuberculous iridocyclitis existed simultaneously with or following periphlebitis, certainly suggests that one cannot exclude tuberculosis as the underlying cause of this clinical picture.

Dr. Gilbert, Hamburg: I agree with von Hippel and Fleischer and take the same standpoint in regard to Marchesani's highly interesting remarks. Stress is laid on this point because shortly after Axenfeld made known his observations and findings of retinal periphlebitis, I reported (*München med. Wchnschr.*) a case of the severest form of iridic tuberculosis in which the local and general course as well as the histologic aspects showed undoubted tuberculosis. At the same time the retina showed serious periphlebitic changes. There was all the more reason for ascribing these pathologic changes to tuberculosis in that death took place some time later from phthisis. This case seems to have received slight attention. On the other hand, I, too, have seen cases of juvenile retinal hemorrhages in which neither tuberculosis nor

syphilis could be determined as a cause, and in which one probably has to accept the etiologic explanation presented today. One need not, on this account, think that there was a mistake in diagnosis in definitely determined and unmistakable cases of tuberculosis of the retinal veins.

DR. SERR, Heidelberg: In answer to von Hippel about the amount of blood injected into the anterior chamber, I generally inject 0.1 cc. and at most 0.15 cc. of blood. Replying to Stock, the difficulties of technic and possible errors of interpretation in these procedures are well known. I am aware of these factors of ambiguity and have laid sufficient stress on them in my paper.

DR. WERDENBERG, Davos: With reference to the comment by Stock, roentgen therapy, like any other form of treatment, carries with it the danger of overdosage, as individual patients may react quite differently to one and the same amount of radiation. As any active intervention may lead to an advance or propagation of the intra-ocular process, the results of which cannot be foreseen, the development of a hyphemia and especially of a hypopyon is an early reaction which cannot be considered free from danger, although there may be exceptions. Replying to Wegner, the longer I treat ocular tuberculosis, the less I should like to get along without the totality of therapeutic factors offered by Alpine residence and the special training of a phthisiatrist. A fusion of ophthalmology and practical investigation of tuberculosis, and the resulting experience, have become, for me, the broadened basis of diagnosis and therapy and have been essential and invaluable to me in the treatment of a large number of patients with ocular tuberculosis.

DR. MARCHESANI, Munich: The involvement of the veins of the eye may be compared to a similar disease of the veins of the extremities which Buerger calls migrating phlebitis. This form of the disease explains the coming and going of the pathologic changes in the eye, a point to which Axenfeld called attention. In the microscopic sections there is, besides, a marked involvement of the arteries. That the disease is especially predominant among Jews, as originally assumed by Buerger, has not been confirmed. His erroneous thesis is explained by his one-sided material. The histologic observations presented by von Hippel do not seem to me convincing as to tuberculosis. On the contrary, these changes, too, might well be considered as thrombo-angiitis. [The speaker then demonstrated the histologic specimens in Fleischer's case and in the case of Axenfeld and Plocher, which he considered typical for obliterating thrombo-angiitis.] In some of the sections in Fleischer's case the iris showed peculiar tuberculoid tissue formations, the nature of which does not appear to have been definitely recognized. One of these specimens, stained specially for elastic tissue, shows unmistakably that one is dealing with obliterated vessels.

(To be concluded)

ROYAL SOCIETY OF MEDICINE, LONDON, SECTION OF OPHTHALMOLOGY

Friday, Nov. 9, 1934

MR. RANSOM PICKARD, C.B., M.S., *President*

A SUCCESSFUL CORNEAL GRAFT, WITH DEMONSTRATION OF THE PATIENT. MR. J. W. TUDOR THOMAS, Cardiff.

Four months after a graft had been implanted in the left cornea, the patient's vision improved from perception of hand movements to a capacity to find his way about London unaided. The patient is a man aged 57, a resident of New Zealand. Considerable corneal opacification and defective sight followed bilateral corneal ulceration at the ages of 17 and 40. The projection of light in each eye was good, but vision was limited to the counting of fingers at 15 inches (38 cm.) with the right eye and detecting hand movements with the left eye.

From the enucleated donor eye a piece of cornea was removed, measuring 4.33 mm. in diameter. The margin of the graft was cut in a shelving manner, and it was placed at once in a watch-glass bath of olive oil. Under cocaine anesthesia, the graft was implanted in the recipient cornea over the pupillary area. Two cross-sutures were inserted to hold the graft in place, and a citrated solution and epinephrine hydrochloride were used to prevent adhesion of the iris. The stitches were removed on the eighth day, and at fourteen days the graft was clear, with the exception of a small white spot near the lower margin. In the shelving margin a few small blood vessels took a circular course. From the eighth to the twentieth day the eyes were covered with a pad and a bandage. At three weeks the white dot was still persistent. The patient left the hospital in a little over a month. On the thirty-fifth day vision was 3/60, and the patient was able to negotiate the curves of the street, read the main headlines of the newspapers, and tell the time by his watch. In seven weeks vision for reading was 4/60, and for two months he had been going about London by himself.

This instance represents the fifteenth attempt to implant a corneal graft in the human eye.

PREOPERATIVE PREPARATION OF THE CONJUNCTIVAL SAC BY ULTRAVIOLET RAYS. MR. F. W. LAW.

Patients awaiting intra-ocular operations may harbor in the conjunctival sac organisms which are definitely pathogenic. Irradiation of the conjunctiva does not usually result in a sterile culture, but does affect pathogenic more than nonpathogenic organisms. In most of the cases in which patients were referred for this treatment, other methods of cleansing the conjunctiva had been tried without success.

A lamp on a movable stand is used, placed 12 inches (30 cm.) from the eye. The head of the patient is mechanically secured, and the lids are everted in such a way as to cover the cornea. The sittings are usually of five minutes' duration, and are given at intervals of two days.

The conclusions drawn are: 1. Ultraviolet irradiation is successful in rendering the eye bacteriologically safe for operation in nearly

every case. 2. Pathogenic organisms are more susceptible to the rays than are nonpathogenic ones. 3. Even if pathogenic organisms are, by this means, only attenuated, operation on the eye can be carried out with safety. 4. It is not advisable to combine the application of antiseptic lotions and silver nitrate with irradiation.

DISCUSSION

MR. A. C. HUDSON: Attempts have been made to clear the conjunctival sac of all contaminations by means of the tungsten arc lamp; these have been carried out at St. Thomas' Hospital by Dr. Bowen, and the few results obtained were encouraging. The organism which is most to be feared is Staphylococcus aureus. In former days it seemed quite hopeless to get a patient whose conjunctival sac was invaded by this organism into a state fit for operation.

MR. G. HANDELSMAN (after relating that he had had success with ultraviolet ray treatment in a series of cases): No success followed the application of the rays for chronic blepharitis of long standing.

MR. D. V. GIRI: If the ultraviolet rays do not kill the germs, they are likely to return to the conjunctival sac from the fornices after the rays are no longer given.

LEFT DIVERGENT CONCOMITANT SQUINT; A MASS PROJECTING INTO THE VITREOUS FROM THE OPTIC DISK. MR. HUMPHRY NEAME.

This youth, aged 21, lost the sight of his left eye almost completely in 1926. There is a long history of headaches and vomiting which began after he had received a blow on the head from a falling chimney-pot. In 1927 Mr. Trotter performed an operation for decompression, and this stopped the vomiting, but headaches recommenced three months later. Lately they have become more severe and are accompanied by vomiting. Projecting forward from the left disk are a mass of fibrous tissue and some fine floating strands.

DISCUSSION

MR. A. C. HUDSON: This might be a case of avulsion of the nerve head due to injury, but it is not typical, because retinal blood vessels are not very obvious.

NEUROFIBROMATOSIS OF THE ORBIT. MR. O. GAYER MORGAN.

According to the parents, this boy, aged 6½ years, was normal at the age of 6 months. Then facial asymmetry began to appear, and has progressed to what one sees now. There is slight ptosis, but no loss of power in the upper lid and no paresis of the seventh nerve on that side. Sensation is normal. The eye is slightly proptosed and is at a lower level than its fellow. There is no limitation of movement in any direction. In both temporal regions there is considerable bossing of the skull, but the x-ray pictures show only a slight displacement of the left orbital roof upward. Though a familial element is common in Recklinghausen's disease, there is no such history in this case. The coffee-colored spots on the abdomen are apparently typical, and it is possible to diagnose the condition on the basis of this alone.

RUPTURE OF DESCEMET'S MEMBRANE FROM CONTUSION. MR. F. A. JULER.

This man, aged 39, came for advice because of symptoms of conjunctival irritation dating from an incident in the War in which he was thrown from a car by a bursting shell, with considerable bruising of the left side of his face. Vision in the left eye for reading is 6/6 partly. The cornea shows on its posterior surface a sinuous line which does not reach the limbus. From this line a shelf, evidently formed by Descemet's membrane, projects back into the anterior chamber. In two places there are some rounded globules growing from the posterior corneal surface in the area of the shell.

DISCUSSION

MR. A. C. HUDSON: Many years ago I showed a similar case in a man who had likewise been blown up by an explosion in the War. He had rupture of Descemet's membrane, with high astigmatism, and there was good evidence that he had had good vision with no astigmatism before the accident.

TWO CASES OF CONGENITAL ABSENCE OF THE EXTERNAL RECTUS, WITH THE GLOBE IN ADDUCTION. MR. R. C. WILLIAMS.

One case is observed in an infant of 18 months; the other, in a girl of 16 years. In each case there is a narrowing of the palpebral fissure with retraction of the globe. In the girl's case there is a convergent squint of the affected eye in addition to the other defect. It is suggested that there is a syndrome present which consists of (1) complete or partial absence of abduction in the affected eye; (2) partial or complete loss of adduction on retraction; (3) retraction on adduction; (4) oblique upward or inward or down and out movement, and (5) narrowing of the palpebral fissure on adduction.

DISCUSSION

MR. R. AFFLECK GREEVES: I have seen a number of similar cases, in some of which an ordinary convergent squint developed also. In the elder of the two patients now shown, the squinting eye is the one in which the muscle is deficient; that is not always the case. I have regarded this syndrome as being characteristic of congenital abnormality of the external rectus, as opposed to the acquired one, which is due probably to injury by forceps. One patient I have followed from infancy. She is now 19 years of age. The eyes were straight in the primary position to begin with, and then a convergent squint of the eye developed, and she had considerable hypermetropia. Glasses straightened the squint, but she still is unable to move the eye outward. A concomitant squint has developed, but there is double vision. It comes from some developmental error, but it is difficult to know how.

SUPERFICIAL KERATITIS. MR. O. GAYER MORGAN.

The condition is of nine years' duration. It commenced when the patient was on his way to the East. The eyes have been completely

free from discomfort since the start; vision has been sufficiently good for him to act as an inspector of police for several years. Cultures have been negative; no focus of infection has been found, and no history of malaria or dysentery has been obtained.

The most striking points in regard to the cornea are: 1. It presents fine branching star-shaped opacities. 2. These opacities are in the epithelium, are elevated, and form, in places, a defect in the surface, as evidenced by their staining with fluorescein. 3. There is no loss of corneal sensation. The lesion is not neuropathic, and it is not familial. It does not belong to the Salzmann group of nodular corneal dystrophy, as that condition in all cases was associated with chronic keratoconjunctivitis, and there was well marked pannus. Suggestions made as to treatment are: to scrape the surface of one eye, or to cause desquamation of the epithelium by the use of some chemical substance or by irradiation.

Book Reviews

Augenärztliche Tagesfragen. By Prof. W. Löhlein and Prof. W. Wegner, Freiburg. Price, 8 marks. Pp. 351. Freiburg: J. Waibel, 1934.

It has been customary in Germany to give from time to time a postgraduate course (*Fortbildungskurs*), lasting one week, in a university town, in which the ophthalmologic problems of the day are presented in lectures and in clinical and operative demonstrations by the ophthalmologists and other members of the medical faculty. This time the meeting was held in the celebrated university town of Freiburg. These lectures have appeared in printed form, so they are available for those who did not take part in the course. It is interesting to observe what subjects were selected as suitable for this course. Most of the lectures were given by Löhlein, the director of the eye clinic, and by Wegner, his first assistant. Löhlein spoke on glaucoma, new medical and radiation therapy, optical correction and contact glasses, while Wegner discussed ocular tuberculosis, fundus diagnosis of increased blood pressure, operations, questions of compensation and the relationship of heredity to blindness. The nonophthalmologic topics were the modern treatment of pulmonary tuberculosis, the pharmacology of drugs reducing the blood pressure, roentgen diagnosis in ophthalmology, ultravisible viruses and heredity. Aschoff spoke on the real and apparent spastic vascular lesions of the retina. Finally, Löhlein contributes a chapter on diagnostic errors.

This excellent collection of lectures contains many points of interest for ophthalmologists.

ARNOLD KNAPP.

Recent Advances in Ophthalmology. By Sir Stewart Duke-Elder. Third edition. Price, $4. Pp. 434, with 3 plates and 150 text pictures. Philadelphia: P. Blakiston's Son & Co., 1934.

In this third edition Duke-Elder has written practically a new book, which means the addition of many new subjects and the omission of subjects in which there have been few recent advances. Thus the purpose of the book, namely, to acquaint the senior student with those facts which are at present situated somewhere between graduation from the literature and adoption by the textbook, is admirably fulfilled. The subject matter is divided into a part on physiology and a part on diseases of the eye. The former treats of the vascular circulation, the intra-ocular fluid, the vitreous body, the intra-ocular pressure and the effect of drugs on the eye; and the latter part considers intra-ocular infections, the ocular pigment and intra-ocular tumors, the conjunctiva, the cornea, the retina, cataract, glaucoma and sympathetic ophthalmitis. Each chapter ends with a list of literary references.

This important work should be read by every ophthalmologist, and its study will prove both profitable and stimulating. Duke-Elder deserves gratitude for his successful presentation of many difficult problems in which his method of approach, based on modern physicochemical principles, is unusual and interesting.

ARNOLD KNAPP.

Cataract; Its Etiology and Treatment. By Clyde A. Clapp, Associate Professor of Ophthalmology, Johns Hopkins University. Price, $4. Pp. 254, with 92 engravings. Philadelphia: Lea & Febiger, 1934.

After a foreword by Prof. W. H. Wilmer, the development and comparative anatomy of the human lens are treated in an authoritative manner by Ida C. Mann. Clapp then takes up in turn the anatomy, nourishment and growth, physiology, chemistry, congenital anomalies and pathogenesis of the lens. The clinical discussion occupies the second half of the book and begins with a description of the various types of cataract. After a chapter on the nonoperative treatment, the operative treatment of the various forms of cataract is gone into thoroughly, from the preparation of the patient, with an outline of the various operations, to the after-care.

Clapp has accomplished his purpose of writing a comprehensive work on the lens, and he has done this well. A comprehensive study is timely, as, though there have been many books on the clinical and operative phases of cataract, there has not been an up-to-date introduction including a discussion of the pathogenesis and the correlation of the results of modern research, which has been so active in recent years.

The book is equipped with good illustrations, and a complete bibliography concludes each chapter.

ARNOLD KNAPP.

Directory of Ophthalmologic Societies *

INTERNATIONAL

International Association for Prevention of Blindness

President: Prof. F. de Lapersonne, 217 Faubourg St. Honoré, Paris.
Secretary-General pro tem: Dr. A. Churchill, 66 Boulevard St. Michel, Paris.

International Ophthalmologic Congress

Secretary: Dr. Francisco Poyales, Olozaga 3, Madrid.
Place: Cairo. Time: 1937.

FOREIGN

British Medical Association, Section on Ophthalmology

President: Dr. A. J. Ballantyne, 11, Sandyford Pl., Glasgow, C 3.
Secretary: Dr. J. Ringland Anderson, 108 Collins St., Melbourne.
Place: Melbourne. Time: Sept. 11-13, 1935.

Ophthalmology Society of Bombay

President: Dr. D. D. Sathaye, 127 Girgaum Road, Bombay 4.
Secretary: Dr. H. D. Dastur, Dadar, Bombay 14.
Place: H. B. A. Free Ophthalmic Hospital, Parel, Bombay 12. Time: First Friday of every month.

Ophthalmological Society of the United Kingdom

President: Mr. R. Foster Moore, 53, Harley St., London, W. I.
Secretary: Miss Ida Mann, 7, Wimpole St., London, W. I.

Oxford Ophthalmological Congress

Master: Dr. C. G. Russ Wood, Hill House, Abberbury Rd., Iffley, Oxford, England.
Hon. Secretary-Treasurer: Dr. F. A. Anderson, 12 St. John's Hill, Shrewsbury, England.
Place: Oxford. Time: July 4-6, 1935.

Royal Society of Medicine, Section of Ophthalmology

President: Dr. A. C. Hudson, 50, Queen Anne St., W. 1, London.
Secretary: Dr. J. D. Magor Carbell, 27, Weymouth St., W. 1, London.

Société Française d'Ophthalmologie

Secretary: Dr. René Onfray, 6 avenue de la Motte Picquet, Paris 7è.

Society of Swedish Ophthalmologists

President: Prof. F. Berg, Uppsala, Sweden.
Secretary: Dr. K. O. Granström, Södermalmstorg 4 III tr., Stockholm, Sö., Sweden.

German Ophthalmological Society

Secretary: Prof. A. Wagenmann, Heidelberg.

NATIONAL

American Medical Association, Scientific Assembly, Section on Ophthalmology

Chairman: Dr. Arthur J. Bedell, 344 State St., Albany, N. Y.
Secretary: Dr. Parker Heath, 1553 Woodward Ave., Detroit.
Place: Atlantic City, N. J. Time: June 10-14, 1935.

* Secretaries of societies are requested to furnish the information necessary to make this list complete and to keep it up to date.

AMERICAN ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. J. M. Wheeler, 635 W. 165th St., New York.
President-Elect: Dr. Wells P. Eagleton, 15 Lombardy St., Newark, N. J.
Executive Secretary-Treasurer: Dr. William P. Wherry, 1500 Medical Arts Bldg., Omaha.
Place: Cincinnati. Time: 1935.

AMERICAN OPHTHALMOLOGICAL SOCIETY

President: Dr. Walter B. Lancaster, Boston.
Secretary-Treasurer: Dr. J. Milton Griscom, 2213 Walnut St., Philadelphia.
Place: Hot Springs, Va. Time: June 5-7, 1935.

NATIONAL SOCIETY FOR THE PREVENTION OF BLINDNESS

President: Mr. William Fellowes Morgan, 50 W. 50th St., New York.
Secretary: Miss Regina E. Schneider, 50 W. 50th St., New York.

SECTIONAL

NEW ENGLAND OPHTHALMOLOGICAL SOCIETY

President: Dr. Hugo B. C. Remer, 128 Newbury St., Boston.
Secretary-Treasurer: Dr. Benjamin Sachs, 483 Beacon St., Boston.
Place: Massachusetts Eye and Ear Infirmary, 243 Charles St., Boston. Time: 8 p. m., third Tuesday of each month from November to April, inclusive.

PACIFIC COAST OTO-OPHTHALMOLOGICAL SOCIETY

President: Dr. Frank B. Kistner, Mayer Bldg., Portland, Ore.
Secretary-Treasurer: Dr. Frederick C. Cordes, 384 Post St., San Francisco.
Place: Portland, Ore. Time: May 20-23, 1935.

PUGET SOUND ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Francis A. Brugman, 509 Olive St., Seattle.
Secretary-Treasurer: Dr. Noble Dick, 1115 Terry Ave., Seattle.
Time: 8 p. m., third Tuesday of each month, except July and August.

ROCK RIVER VALLEY EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Harry Shearer, 405 E. Grand Ave., Beloit, Wis.
Secretary-Treasurer: Dr. W. S. Beyer, 1101 Talcott Bldg., Rockford, Ill.
Place: Rockford, Ill., Janesville or Beloit, Wis. Time: Third Tuesday of each month.

SAGINAW VALLEY ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Charles H. Baker, 805 Washington Ave., Bay City, Mich.
Secretary-Treasurer: Dr. W. K. Slack, 308 Eddy Bldg., Saginaw, Mich.
Place: Saginaw, Mich., or Bay City, Mich. Time: First Friday of each month, except July and August.

SIOUX VALLEY EYE AND EAR ACADEMY

President: Dr. J. J. Hompes, 1307 N St., Lincoln, Nebr.
Secretary-Treasurer: Dr. J. C. Decker, Francis Bldg., Sioux City, Iowa.

SOUTHERN MEDICAL ASSOCIATION, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. William A. Wagner, 914 American Bank Bldg., New Orleans.
Secretary: Dr. O. M. Marchman, Medical Arts Bldg., Dallas, Texas.
Place: St. Louis. Time: November 1935.

SOUTHWESTERN MICHIGAN TRIOLOGICAL SOCIETY

President: Dr. F. B. Fralich, 203 S. Main St., Ann Arbor, Mich.
Secretary-Treasurer: Dr. A. S. Barr, 201 S. Main St., Ann Arbor, Mich.
Time: Third Thursday of alternate months.

WESTERN PENNSYLVANIA EYE, EAR, NOSE AND THROAT SOCIETY
President: Dr. Claude W. McKee, 229 S. Main St., Greensburg.
Secretary-Treasurer: Dr. C. W. Beals, 41 N. Brady St., DuBois.
Place: Indiana. Time: October 1935.

STATE

COLORADO OPHTHALMOLOGICAL SOCIETY
President: A presiding officer is selected for each meeting alternately until all members have served.
Secretary: Dr. Edna M. Reynolds, 227, 16th St., Denver.
Place: Capitol Life Building, Denver. Time: 7:30 p. m., third Saturday of the month, October to April, inclusive.

CONNECTICUT STATE MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT
President: Dr. Arthur M. Yudkin, 257 Church St., New Haven.
Secretary-Treasurer: Dr. Walter L. Hogan, 750 Main St., Hartford.
Time: May, November.

EYE, EAR, NOSE AND THROAT CLUB OF GEORGIA
President: Dr. Herschel C. Crawford, 26 Lindon Ave., N. E., Atlanta.
Secretary-Treasurer: Dr. J. A. Smith, 700 Spring St., Macon.
Place: Atlanta. Time: May 7-10, 1935.

INDIANA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. Ora G. Brubaker, North Manchester.
Secretary: Dr. Frederick V. Overman, 705 Hume-Mansure Bldg., Indianapolis.
Place: Indianapolis. Time: April 10, 1935.

IOWA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. F. W. Dean, 532, 1st Ave., Council Bluffs.
Secretary-Treasurer: Dr. O. L. Thorburn, 213½ Main St., Ames.
Place: Council Bluffs. Time: 1935.

MICHIGAN STATE MEDICAL SOCIETY, SECTION OF OPHTHALMOLOGY AND OTOLARYNGOLOGY
Chairman: Dr. John W. Orr, 503 S. Saginaw St., Flint.
Secretary: Dr. D. R. Heetderks, 26 Sheldon Ave., S. E., Grand Rapids.

MINNESOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. James A. Reynolds, 78 S. 9th St., Minneapolis.
Secretary-Treasurer: Dr. Walter E. Camp, Medical Arts Bldg., Minneapolis.
Time: Second Friday of each month from October to May.

MONTANA ACADEMY OF OTO-OPHTHALMOLOGY
President: Dr. Lawrence G. Dunlap, 101 Main St., Anaconda.
Secretary: Dr. A. W. Morse, Phoenix Bldg., Butte.

NEW JERSEY STATE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY, OTOLOGY AND RHINOLARYNGOLOGY
Chairman: Dr. James A. Fisher, 501 Grand Ave., Asbury Park.
Secretary: Dr. William K. Campbell, 96 Third Ave., Long Branch.

NEW YORK STATE MEDICAL SOCIETY, EYE, EAR, NOSE AND THROAT SECTION
Chairman: Dr. Webb W. Weeks, 20 E. 53rd St., New York.
Secretary: Dr. John F. Fairbain, 925 Delaware Ave., Buffalo.
Place: Albany. Time: May 13-15, 1935.

NORTH DAKOTA ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY
President: Dr. W. R. Winn, 702 First Ave., S., Fargo.
Secretary-Treasurer: Dr. F. L. Wicks, 516 Fourth St., Valley City.
Place: Minot. Time: June, 1935.

OREGON ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. A. B. Dykman, Medical Dental Bldg., Portland.
Secretary-Treasurer: Dr. Andrew J. Browning, 418 Mayer Bldg., Portland.
Place: Good Samaritan Hospital. Time: Third Tuesday of each month.

RHODE ISLAND OPHTHALMOLOGICAL AND OTOLOGICAL SOCIETY

Acting President: Dr. Nathan Bolotow, 108 Waterman St., Providence.
Secretary and Treasurer: Dr. Gordon J. McCurdy, 122 Waterman St., Providence.
Place: Rhode Island Medical Library. Time: 8:30 p. m., second Thursday in October, December, February and April.

SOUTH CAROLINA SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Walter Bristow, Medical Bldg., Columbia.
Secretary: Dr. J. W. Jervey Jr., 101 Church St., Greenville.

TENNESSEE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

President: Dr. Eugene Orr, 706 Church St., Nashville.
Secretary-Treasurer: Dr. W. D. Stinson, 248 Madison Ave., Memphis.

TEXAS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. T. E. Fuller, 100 W. Broad St., Texarkana, Texas.
Secretary: Dr. O. M. Marchman, 1719 Pacific Ave., Dallas.

UTAH OPHTHALMOLOGICAL SOCIETY

President: Dr. William Stookey, 54 E. South Temple St., Salt Lake City.
Secretary-Treasurer: Dr. T. F. Welsh, 711 Boston Bldg., Salt Lake City.
Time: Third Monday of each month.

VIRGINIA SOCIETY OF OTO-LARYNGOLOGY AND OPHTHALMOLOGY

President: Dr. Beverley R. Kennon, 142 W. York St., Norfolk.
Secretary-Treasurer: Dr. George G. Hankins, Medical Arts Bldg., Newport News.

WEST VIRGINIA STATE MEDICAL ASSOCIATION, EYE, EAR, NOSE AND THROAT SECTION

President: Dr. W. F. Beckner, 1050 Fifth Ave., Huntington.
Secretary: Dr. F. O. Marple, First Huntington National Bank Bldg., Huntington.
Place: Wheeling. Time: May 1935.

LOCAL

ACADEMY OF MEDICINE OF NORTHERN NEW JERSEY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Alfred Stahl, 55 Lincoln Park, Newark, N. J.
Secretary: Dr. A. Russell Sherman, 671 Broad St., Newark.
Place: 91 Lincoln Park South, Newark. Time: 8:45 p. m., second Monday of each month, October to May.

ATLANTA EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Herschel Crawford, 478 Peachtree St., N. E., Atlanta, Ga.
Secretary: Dr. Stacy C. Howell, 384 Peachtree St., N. E., Atlanta, Ga.
Place: Academy of Medicine, 13 Queen's Park. Time: 8 p. m., last Thursday of each month.

BALTIMORE MEDICAL SOCIETY, SECTION ON OPHTHALMOLOGY

Chairman: Dr. Lloyd B. Whitham, Mt. Vernon Pl. and Charles St., Baltimore.
Secretary: Dr. Mary L. Small, 18 W. Read St., Baltimore.
Place: Medical and Chirurgical Faculty, 1211 Cathedral St. Time: 8:30 p. m., fourth Thursday of each month from October to May.

Brooklyn Ophthalmological Society

President: Dr. John H. Bailey, 855 St. Marks Ave., Brooklyn.
Secretary-Treasurer: Dr. George Freiman, 703 Grand St., Brooklyn.
Place: Kings County Medical Society Bldg., 1313 Bedford Ave. Time: Third Thursday in February, April, May, October and December.

Buffalo Ophthalmologic Club

President: Dr. H. H. Glosser, 448 Franklin St., Buffalo.
Secretary-Treasurer: Dr. I. J. Koenig, 40 North St., Buffalo.
Time: Second Thursday of each month.

Chicago Ophthalmological Society

President: Dr. E. V. L. Brown, 122 S. Michigan Ave., Chicago.
Secretary-Treasurer: Dr. Thomas D. Allen, 122 S. Michigan Ave., Chicago.
Place: Medinah Michigan Avenue Club, 505 N. Michigan Ave. Time: Third Monday of each month from October to May.

Cleveland Academy of Medicine, Section of Ophthalmology and Otolaryngology

Chairman: Dr. A. D. Ruedemann, 2020 E. 93d St., Cleveland.
Secretary: Dr. Fred W. Dixon, 1029 Rose Bldg., Cleveland.
Place: Winton Hotel. Time: Fourth Friday of each month.

Cleveland Ophthalmological Club

Chairman: Dr. W. P. Chamberlain, 7405 Detroit Ave., Cleveland.
Secretary: Dr. A. D. Ruedemann, Cleveland Clinic, Cleveland.

College of Physicians, Philadelphia, Section on Ophthalmology

Chairman: Dr. John Milton Griscom, 2213 Walnut St., Philadelphia.
Clerk: Dr. Alexander G. Fewell, 1924 Pine St., Philadelphia.
Time: Third Thursday of every month from October to April, inclusive.

Columbus Ophthalmological and Oto-Laryngological Society

Chairman: Dr. W. C. Davis, 327 E. State St., Columbus, Ohio.
Secretary-Treasurer: Dr. H. M. Sage, 9 Buttles Ave., Columbus, Ohio.
Place: Athletic Club. Time: First Monday of each month.

Dallas Academy of Ophthalmology and Oto-Laryngology

President: Dr. W. Mood Knowles, 1719 Pacific Ave., Dallas, Texas.
Secretary: Dr. L. H. Quinn, 4015 Live Oak St., Dallas, Texas.
Place: Dallas Athletic Club. Time: 6:30 p. m., first Tuesday of each month from October to June. The November, January and March meetings are devoted to clinical work.

Des Moines Academy of Ophthalmology and Otolaryngology

President: Dr. C. C. Walker, 410 6th Ave., Des Moines, Iowa.
Secretary-Treasurer: Dr. Grace Doane, 614 Bankers Trust Bldg., Des Moines, Iowa.
Time: 7:45 p. m., third Monday of every month, September to May.

Detroit Ophthalmological Club

Chairman: Members rotate alphabetically.
Secretary: Dr. Raymond S. Goux, David Whitney Bldg., Detroit.
Time: 6:30 p. m., first Wednesday of each month.

Eastern New York Eye, Ear, Nose and Throat Association

President: Dr. Arthur F. Holding, 142 Washington Ave., Albany.
Secretary-Treasurer: Dr. W. C. Mott, 214 State St., Albany.
Time: Third Wednesday in October, November, March, April, May and June.

Fort Worth Eye, Ear, Nose and Throat Society

President: Dr. T. L. Goodman, 602 W. 10th St., Fort Worth, Texas.
Secretary-Treasurer: Dr. Van D. Rathgeber, 1012 Medical Arts Bldg., Fort Worth.
Place: Medical Hall, Medical Arts Bldg. Time: 7:30 p. m., first Friday of each month except July and August.

Grand Rapids Eye, Ear, Nose and Throat Society

President: Dr. John H. McRae, 26 Sheldon Ave., S. E., Grand Rapids, Mich.
Secretary-Treasurer: Dr. Robert G. Laird, 307 Metz Bldg., Grand Rapids, Mich.
Place: Various local hospitals. Time: Third Thursday of alternating months, September to May.

Houston Academy of Medicine, Eye, Ear, Nose and Throat Section

President: Dr. R. M. Hargrove, 1202 Esperson Bldg., Houston, Texas.
Secretary: Dr. J. C. Dickson, 1617 Medical Arts Bldg., Houston, Texas.
Place: Medical Arts Bldg., Harris County Medical Society Rooms. Time: 8 p. m., second Thursday of each month from September to June.

Indianapolis Ophthalmological and Otolaryngological Society

President: Dr. C. H. McCaskey, 404 Continental Bank Bldg., Indianapolis.
Secretary: Dr. Kenneth L. Craft, 23 E. Ohio St., Indianapolis.
Place: University Club. Time: 6:30 p. m., second Thursday of each month from October to May.

Kansas City Society of Ophthalmology and Oto-Laryngology

President: Dr. Raymond E. Teall, 1103 Grand Ave., Kansas City, Mo.
Secretary: Dr. A. W. McAlester, 2003 Bryant Bldg., Kansas City, Mo.
Time: Third Thursday of each month from September to May. The November, January and March meetings are devoted to clinical work.

Long Beach Eye, Ear, Nose and Throat Society

Chairman: Dr. Russell T. Uhls, 110 Pine Ave., Long Beach, Calif.
Secretary-Treasurer: Dr. Kenneth C. Brandenburg, 707 Security Bldg., Long Beach, Calif.
Place: Professional Bldg. Time: Last Wednesday of each month from October to May.

Los Angeles Society of Ophthalmology and Oto-Laryngology

President: Dr. F. H. Brandt, 1136 W. Sixth St., Los Angeles.
Secretary-Treasurer: Dr. Pierre Viole, 1930 Wilshire Blvd., Los Angeles.
Place: Los Angeles County Medical Association Bldg., 1925 Wilshire Blvd. Time: 6:30 p. m., fourth Monday of each month from September to May, inclusive.

Louisville Eye, Ear, Nose and Throat Society

President: Dr. Charles Dwight Townes, 332 W. Broadway, Louisville, Ky.
Secretary-Treasurer: Dr. J. S. Bumgardner, 1103 Heyburn Bldg., Louisville, Ky.
Place: French Village. Time: 6:30 p. m., second Thursday of each month from September to May, inclusive.

Medical Society of the District of Columbia, Section of Ophthalmology and Oto-Laryngology

Chairman: Dr. R. S. Pendexter, 900, 17th St., N. W., Washington.
Secretary: Dr. Lyman B. Tibbets, 1801 Eye St., N. W., Washington.
Place: 1718 M St., N. W. Time: 8 p. m., third Friday of each month from October to April, inclusive.

MEMPHIS SOCIETY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Each member, in alphabetical order.
Secretary: Dr. R. O. Rychener, 130 Madison Ave., Memphis, Tenn.
Place: Eye Clinic of Memphis Eye, Ear, Nose and Throat Hospital. Time: 8 p. m., second Tuesday of each month.

MILWAUKEE OTO-OPHTHALMIC SOCIETY

President: Dr. J. J. Brook, 231 W. Wisconsin Ave., Milwaukee.
Secretary-Treasurer: Dr. Herbert G. Schmidt, 238 W. Wisconsin Ave., Milwaukee.
Place: University Club. Time: 6:30 p. m., fourth Tuesday of each month.

MONTREAL OPHTHALMOLOGICAL SOCIETY

President: Dr. J. A. MacMillan, 1410 Stanley St., Montreal, Canada.
Secretary: Dr. A. L. Guertin, 410 Sherbrooke St., West, Montreal, Canada.
Time: Second Thursday of October, December, February and April.

NASHVILLE ACADEMY OF OPHTHALMOLOGY AND OTOLARYNGOLOGY

Chairman: Dr. Wesley Wilkerson, Bennie Dillon Bldg., Nashville, Tenn.
Secretary-Treasurer: Dr. Hale Cullom, Bennie Dillon Bldg., Nashville, Tenn.
Place: St. Thomas Hospital. Time: 8 p. m., third Monday of each month from October to June.

NEW ORLEANS OPHTHALMOLOGICAL AND OTOLARYNGOLOGICAL SOCIETY

President: Dr. R. H. Fisher, Chess and Checker Club, New Orleans.
Secretary-Treasurer: Dr. H. F. Brewster, 837 Gravier St., New Orleans.
Place: Eye, Ear, Nose and Throat Hospital. Time: Third Thursday of each month from October to June.

NEW YORK ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Webb William Weeks, 20 E. 53d St., New York.
Secretary: Dr. Guernsey Frey, 121 E. 60th St., New York.
Time: 8:30 p. m., third Monday of every month from October to May, inclusive.

OMAHA AND COUNCIL BLUFFS OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. John H. Judd, 107 S. 17th St., Omaha.
Secretary-Treasurer: Dr. Robert H. Rasgorshek, 425 Aquila Court, Omaha.
Place: Omaha Club, 20th and Douglas Sts., Omaha. Time: 6 p. m., dinner; 7 p. m., program; third Wednesday of each month from October to May.

PHILADELPHIA COUNTY MEDICAL SOCIETY, EYE SECTION

Chairman: Dr. Charles R. Heed, 1205 Spruce St., Philadelphia.
Secretary: Dr. Sidney L. Olsho, 235 S. 15th St., Philadelphia.
Time: First Thursday of each month from October to May.

PITTSBURGH OPHTHALMOLOGICAL SOCIETY

President: Dr. Edward B. Heckel, 500 Penn Ave., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: Pittsburgh Academy of Medicine Bldg. Time: Fourth Monday of each month, except June, July, August and September.

PITTSBURGH SLIT-LAMP SOCIETY

President: Dr. W. W. Blair, 121 University Pl., Pittsburgh.
Secretary: Dr. George H. Shuman, Park Bldg., Pittsburgh.
Place: 121 University Pl. Time: Second Monday evening of every month, except June, July, August and September.

RICHMOND OPHTHALMOLOGICAL AND OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Samuel M. Cottrell, 116 E. Franklin St., Richmond, Va.
Secretary: Dr. Richard W. Vaughan, Medical Arts Bldg., Richmond, Va.
Place: Westmoreland Club. Time: 6 p. m., second Monday of each month from October to May.

ROCHESTER EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. Frank Barber, 75 S. Fitzhugh St., Rochester, N. Y.
Secretary-Treasurer: Dr. Laurence Macey, 221 Alexander St., Rochester, N. Y.
Place: Rochester Medical Association, 113 Prince St. Time: 8 p. m., third Monday of each month from October to May.

ST. LOUIS OPHTHALMIC SOCIETY

President: Dr. Meyer Wiener, 308 N. 6th St., St. Louis.
Secretary: Dr. W. M. James, Metropolitan Bldg., St. Louis.
Place: Oscar Johnson Institute. Time: Clinical meeting 5:30 p. m., dinner and scientific meeting 6:30 p. m., fourth Friday of each month from October to April, inclusive, except December.

SAN ANTONIO OPHTHALMOLO-OTO-LARYNGOLOGICAL SOCIETY

President: Dr. Robert E. Parrish, 712 Medical Arts Bldg., San Antonio, Texas.
Secretary-Treasurer: Dr. Frank Steed, Nix Professional Bldg., San Antonio, Texas.
Place: Bexar County Medical Library. Time: 8 p. m., first Tuesday of each month from October to May.

SAN FRANCISCO COUNTY MEDICAL SOCIETY, SECTION ON EYE, EAR, NOSE AND THROAT

Chairman: Dr. Frank H. Rodin, 490 Post St., San Francisco.
Secretary: Dr. Louis F. Morrison, 490 Post St., San Francisco.
Place: Society's Building, 2180 Washington St., San Francisco.
Time: Fourth Tuesday of every month except May, June, July and December.

SHREVEPORT EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. W. L. Atkins, 940 Margaret Pl., Shreveport, La.
Secretary-Treasurer: Dr. Leon F. Gray, 1214 Slattery Bldg., Shreveport, La.
Place: 1240 Texas Ave. Time: 8:15 p. m., fourth Tuesday of every month except June, July and December.

SPOKANE ACADEMY OF OPHTHALMOLOGY AND OTO-LARYNGOLOGY

President: Dr. Marc Anthony, 422 Riverside Ave., Spokane, Wash.
Secretary: Dr. Raymond A. Lower, 1455 Paulsen Medical and Dental Bldg., Spokane, Wash.
Place: Paulsen Medical and Dental Library. Time: 8 p. m., fourth Tuesday of each month except June, July and August.

SYRACUSE EYE, EAR, NOSE AND THROAT SOCIETY

President: Dr. D. F. Gillette, 109 S. Warren St., Syracuse, N. Y.
Secretary-Treasurer: Dr. W. J. Werfelman Jr., 725 State Tower Bldg., Syracuse, N. Y.
Place: University Club. Time: Second Friday of each month except June, July and August.

TORONTO ACADEMY OF MEDICINE, SECTION OF OPHTHALMOLOGY

Chairman: Dr. Clarence E. Hill, 160 Bloor St., West, Toronto.
Secretary: Dr. A. Lloyd Morgan, 86 Bloor St., West, Toronto.
Time: First Monday, November to April.

WASHINGTON, D. C., OPHTHALMOLOGICAL SOCIETY

President: Dr. William Thornwall Davis, 927 Farragut Sq., Washington, D. C.
Secretary-Treasurer: Dr. James N. Greear Jr., 1740 M St., N. W., Washington, D. C.
Place: Episcopal Eye and Ear Hospital. Time: 8 p. m., first Thursday in November, January, March and May.